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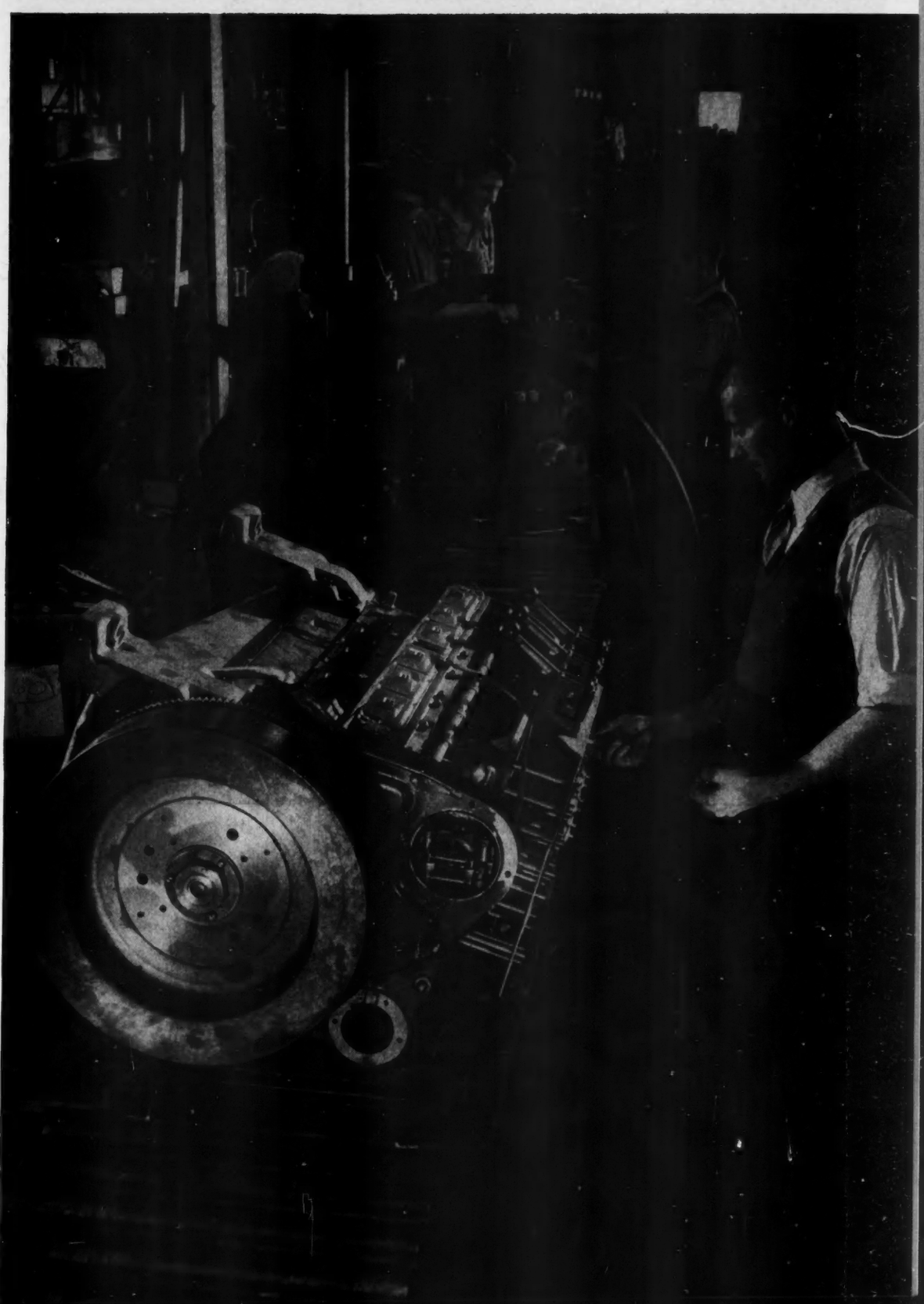

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THE UNIVERSITY
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ENGINEERING

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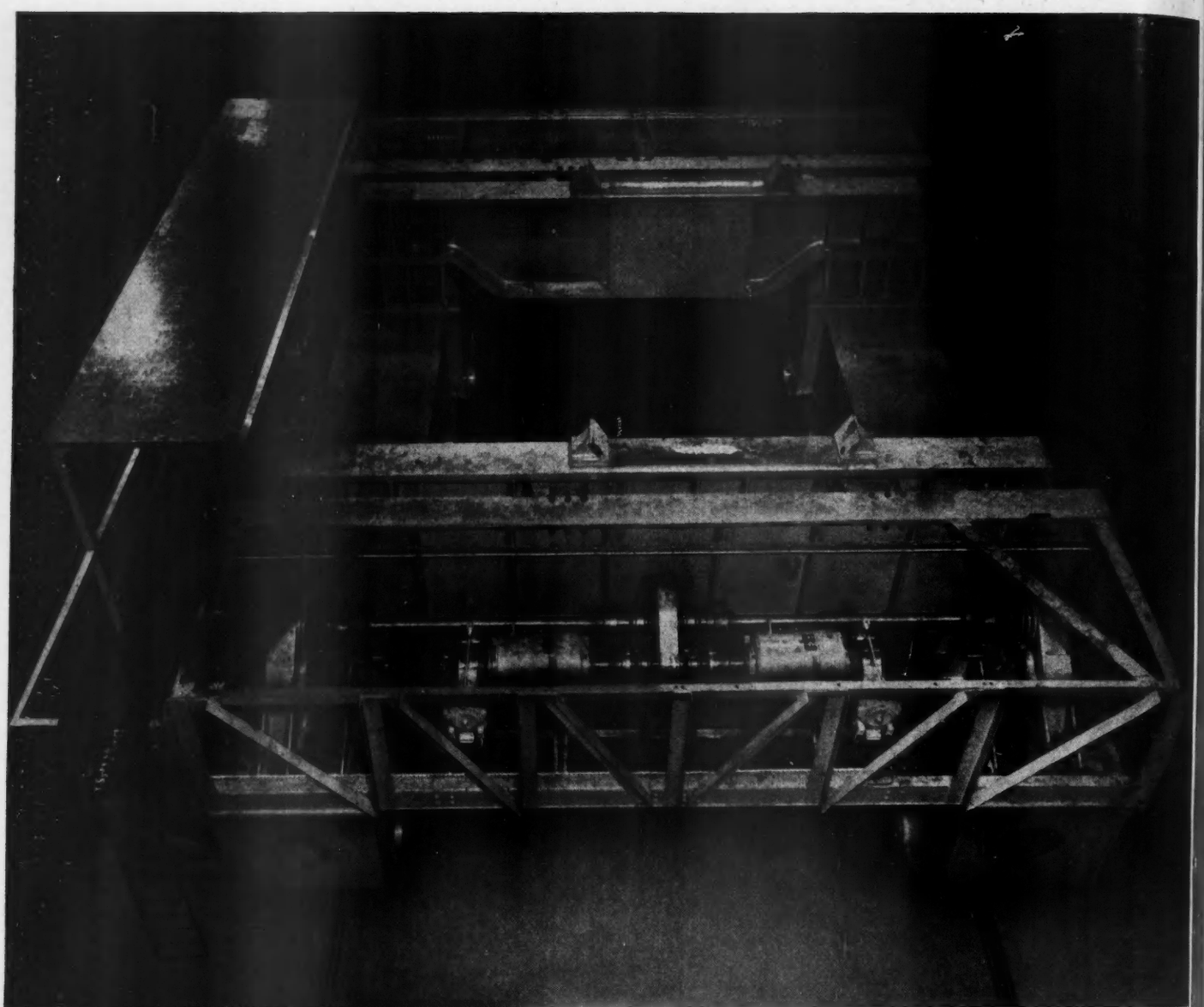
ng Cylinder Heads

HANDLING HOT METAL THE DISTINGTON WAY



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20 January 1961

Vol. 191 No. 4944

Founded in 1866

ENGINEERING

PUBLISHED EVERY FRIDAY

36 Bedford Street London WC2 England Telephone: Temple Bar 3663

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Fitting cylinder heads in the horizontal position on six-cylinder engines. (*Nurnberg photograph for* ENGINEERING)

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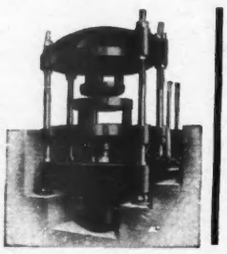

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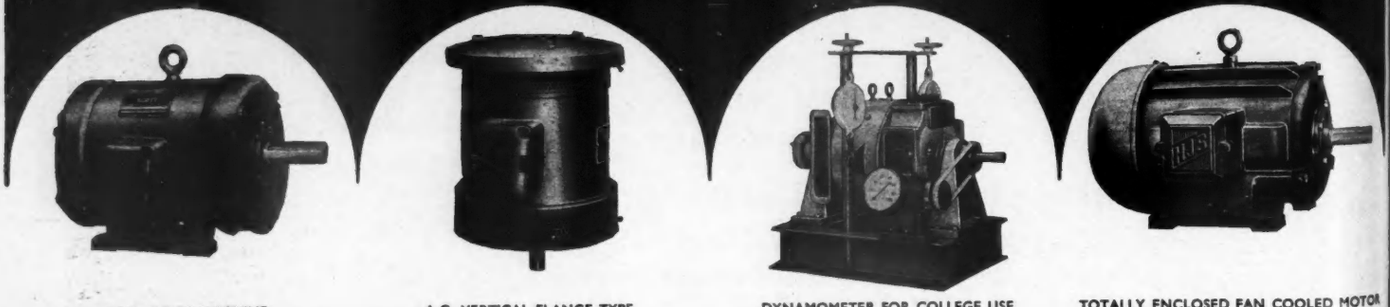

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ENGINEERING Impact

of Incentives and the Engineering Vocation

AVERAGE earnings and conventional career prospects are not the first things that spring to mind in considering the motives and the drives behind the choice of their life's work made by men of the quality of Brunel or Sir Christopher Hinton.

But a complex industrial society must for its continued existence secure not only the isolated leaders of genius and persistence, but thousands of highly educated professional men, among them the engineers, to keep the whole machine working, to extend its activities and improve its efficiency.

The facts revealed by the full detailed release by the Engineers' Guild of their survey of engineers' earnings in the year 1959/60 indicate that a substantial change for the better has been taking place in the financial reward to be expected from an engineering career. Such an improvement must have two main effects.

Higher salaries in any occupation—if they end a situation in which its members feel themselves badly treated in relation to other, similarly trained, professional workers—make for better morale, for greater attention to work rather than to personal conditions. A better financial prospect has its influence, too, on the careers master in the schools, on the thinking parent, and eventually on the quality of entry into the profession.

The second, and perhaps more important effect, is on the way management, including its proportion of engineers, thinks about the fully effective employment of its professional engineers. Any noticeably rising part of the costs tend to be critically examined, if not to put a stop to the increase at least to make certain that the best possible results are being obtained.

In a great number of firms the engineers themselves, and the management, carry to a very high point the employment of the creative skill of the engineer, reducing time lost on routine matters to a minimum. Not surprisingly, the will to improve the application of engineering abilities is strong in those firms where the point has always received attention.

The result, then, of the improving standards shown by the Guild's survey can be predicted as a rising standard of entry into the profession and a tendency for the proportion of engineers who do not have scope to exercise their full ability to decrease. The benefit to industry appears likely to be considerable.

General Improvement

The Engineers' Guild sent 4,402 of their earnings questionnaires to corporate members of the Institutions of Civil, Mechanical, Electrical and Chemical Engineers living in the United Kingdom; 3,134 replies were received, the responses from the members of each Institution being close together. They varied only from the Mechanicals at 69·5 per cent up to the Civils at 73·1 per cent.

Comparison with the results of the 1955/56 survey (for the Royal Commission on Doctors' and Dentists' Remuneration) show that not only have the bulk of engineers moved substantially up the income ladder, the proportion of those earning salaries that show a measure of success has sharply increased.

The largest increases in the higher grades have taken place in the £2,400 to £2,799 sector which has doubled from 2·7 per cent of the 1955-56 sample to 5·9 per cent in 1960. The percentage earning from £2,800 to £3,199 has gone up from 1·6 per cent to 3·4.

From 5·8 per cent in the earlier survey, the numbers receiving between £2,000 and £2,399 have risen to 9·7 per cent. At the top, the proportion over £3,200 has moved up from 4·3 per cent to 7·1.

At the more populous lower end, the 1955-56 survey showed almost half its sample, 43·9 per cent, earning between £800 and £1,199. Now the figure in this bracket has declined to 14·4 per cent. The largest single group, 37·7 per cent, are now in the £1,200/£1,599 sector (1955/56—23·5).

In the bracket just below surtax £1,600/£1,999, there are now 21·4 per cent, against 10·6.

The Guild's survey throws revealing light on the relationship of graduate to non-graduate engineers, both in their salaries and in one Institution compared with another. In the under 35 age group, graduates in the lower quartile section averaged £1,215, non-graduates £1,101. For those who have advanced further, in earnings, while still comparatively young, the difference at the upper quartile is marked, graduates averaged £1,587 and non-graduates £1,400 (under 35).

Well Paid Youth

At the highest salary averages there was well over £1,000 difference. The figures were, for the 55-64 age group, lower quartile, graduates £1,900, non-graduates £1,492. The upper quartile figures for the 55/64's were graduates £3,850, non-graduates £2,491.

Within the sample the breakdown of graduates and non-graduates in the Institutions were: Civils, 312 graduates, non-graduates 197; Mechanicals, 270 graduates, 751 non-graduates; Electricals, 347 graduates, 474 non-graduates; Chemicals, 209 graduates, 109 non-graduates.

An intriguing conclusion to be drawn from the survey's figures—though not one to be pushed too far—is that average salaries tend to rise in inverse proportion to the age of the Institution. Thus the lower quartile of non-graduates for the Civils, Mechanicals, Electricals and Chemicals, in that order, ascends £1,238, £1,246, £1,259, £1,638.

The upper quartile for graduates and non-graduates of the four Institutions show some significant differences. They were:

	£
Civils—	
Graduates	2,043
Non-Graduates	1,785
Mechanicals—	
Graduates	2,627
Non-Graduates	1,800
Electricals—	
Graduates	2,450
Non-Graduates	1,798
Chemicals—	
Graduates	3,094
Non-Graduates	2,983

It is possible to deduce from the survey a general idea of how the varied body of graduates, non-graduates, young civil engineers, mature mechanicals and so on are moving on a salary ladder which has the characteristic of narrowing sharply towards the upper rungs.

For their value in acting as incentives in attracting the best possible entry to the profession it is the highest, upper quartile, incomes that carry the most weight. The figures are Civils £1,968; Mechanicals £1,994; Electricals £2,057; and Chemicals £3,087.

Civil Service Engineers

Although in the middle grades engineers in the Civil Service have improved their position—the median has risen from £1,265 to £1,611—at the higher levels their opportunities are shown to be not so favourable. The upper quartile for the Civil Service engineers is given as £1,963 (£1,545 in 1955/56).

The highest upper quartile of the whole survey is £3,700—earned by members of the Institutions who were "not in engineering occupations." This was explained to ENGINEERING by the secretary of the Engineers' Guild as meaning that the individual who came within this section was not holding his post primarily because of his training as an engineer.

That engineers appear to earn more outside the direct pursuit of their profession than within it is in no way a discouragement. In a time increasingly dependent upon machines and upon advancing efficiency it should be plain that an engineering education can well fit a man for other, perhaps wider, responsibilities in his career.

The Engineers' Guild survey shows that things have been moving in the right direction for engineers, that more thought and effort and inquiry is needed upon engineering rewards and deployment of engineers, and that the status and opportunities for service of the engineering profession are moving forward.

CHARACTERISTICS OF INCOME DISTRIBUTION

—	Number of Engineers	Lower Quartile 1959/60 (*1955/56*)	Median 1959/60 (*1955/56*)	Upper Quartile 1959/60 (*1955/56*)
		£	£	£
All in the United Kingdom	2,463	1,304 (*950*)	1,574 (*1,181*)	2,042 (*1,600*)
Age—Under 35	497	1,145 (*837*)	1,316 (*953*)	1,540 (*1,110*)
35 to 39	658	1,292 (*965*)	1,501 (*1,142*)	1,789 (*1,376*)
40 to 44	343	1,365 (*1,040*)	1,632 (*1,281*)	2,115 (*1,659*)
45 to 54	585	1,419 (*1,150*)	1,778 (*1,484*)	2,474 (*2,000*)
55 to 64	337	1,620 (*1,216*)	2,048 (*1,652*)	2,977 (*2,305*)
65 and over	33	(Number too	small for reliable	figures)
Corporate Members of:				
Institution of Civil Engineers	514	1,269 (*900*)	1,515 (*1,140*)	1,968 (*1,640*)
Institution of Mechanical Engineers	1,031	1,302 (*980*)	1,567 (*1,210*)	1,944 (*1,640*)
Institution of Electrical Engineers	830	1,312 (*960*)	1,584 (*1,190*)	2,057 (*1,560*)
Institution of Chemical Engineers	326	1,737 —	2,175 —	3,087 —
Fields of Employment:				
Commerce and industry (not nationalised), excluding UKAEA	1,134	1,303 (*951*)	1,567 (*1,181*)	2,044 (*1,650*)
Nationalised industries and UKAEA	383	1,279 —	1,530 —	1,992 —
Civil Service	245	1,356 (*1,066*)	1,611 (*1,265*)	1,963 (*1,545*)
Local Authorities (excluding teachers) and Public Utilities	240	1,193 (*824*)	1,381 (*968*)	1,775 (*1,360*)
Regions				
England and Wales	2,231	1,310 —	1,581 —	2,052 —
Scotland and Northern Ireland	216	1,248 —	1,500 —	1,933 —
All engineers in the UK, but excluding members of the Institution of Chemical Engineers and replies where membership of Institution is unknown (for direct comparison with 1955/56 survey)	2,375	1,297	1,562	2,009
Certain Main Occupations				
Consultancy—private practice and salaried employment	141	1,280 —	1,572 —	2,470 —
Not in engineering occupations	90	1,879 (*1,190*)	2,714 (*1,620*)	3,700 (*2,470*)

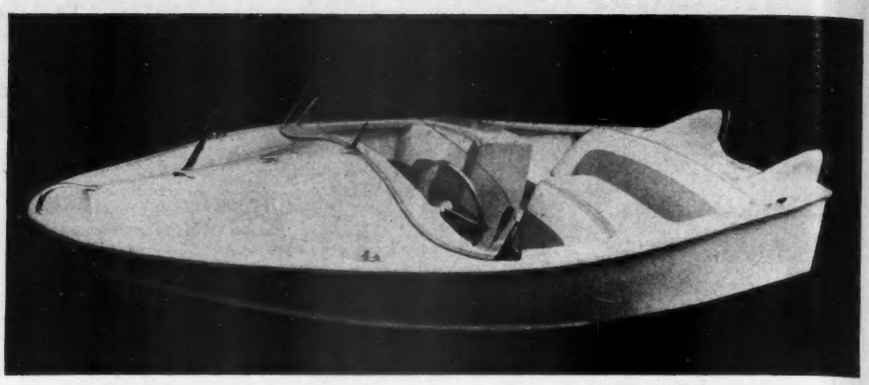
The International Boat Show, sponsored by the *Daily Express* and organised by the Ship and Boat Builders' National Federation, was held from 4 to 14 January at Earls Court and not at Olympia as stated last week.

Commercial Honeycomb Makes Good Sense

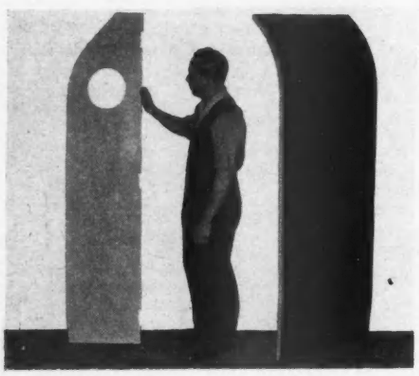
Honeycomb is a means of obtaining high strength to weight structures at low cost. Outside the aircraft industry, flat and single curvature panels can be made very simply.

THERE has been a great deal of sophisticated writing on the use and testing of honeycomb panels in the aircraft industries. But the sights are now placed so high—on welding expensive stainless steel honeycomb for instance—that it is good to see two UK makers of the materials trying to convince the commercial user that there's something in it for him too. And the future of down-to-earth honeycomb relies very little on sophisticated design thinking. Far more good will come from a try-it-and-see attitude.

CIBA (ARL) Limited, one of the two companies, after much development work in the aircraft industries with aluminium honeycomb, are now expanding their promotion in the commercial world with two cheaper grades. Dufaylite Developments Limited, the other company, were created in 1955 to exploit the honeycomb technique developed for Dufay Limited. Technical help is available from both.



***Easy to use.**—Apex Marine, who make this pretty runabout, are the first firm to really use honeycomb in commercial boat construction. Floors of this Ceabird Mark II and their Ceawrens are made from ¾ in thick Kraft honeycomb which becomes impregnated with polyester resin during application of the glass reinforced polyester skins. Five angle iron strips are laid between the skins to further increase rigidity. The firm like paper honeycomb not only for its rigidity, but also for the ease of manufacture without expensive tooling. The 5 ft square roof of their Ceacruiser is of similar construction only without the angle iron.*



***Sound reducing bulkheads.**—In the new Reinforced Plastics Division of English Electric Company, bulkheads are being made as standard items in phenolic resinated Kraft honeycomb for the Deltic locomotive. The core is 1 in thick, placed between glass reinforced polyester envelopes. 2,000 sq. ft have been supplied by Dufaylite so far. Their rigidity helps reduce sound reverberation.*

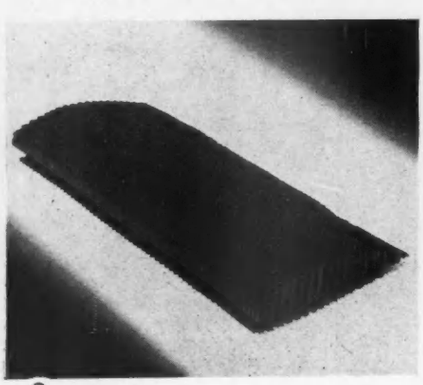
On the right hand page you will find an almost complete list of the materials to try, with addresses of the makers and basic prices at the date of publication. Around the pages you can see just a few of the firms who are using honeycomb. Most of these are already in large scale production.

To start with, it is worth thinking why honeycomb is a useful material if it could be handled easily in production. The main argument in favour of it is that one can obtain very great strength to weight ratios. It should be realised, however, that "honeycomb" is a misnomer—the man-made variety has very strongly directional properties and, without skins, it is only in one direction, parallel to the cell axes, that the strength is reasonable. The big advance comes when honeycombs are used as spacer materials in the same way that expanded polystyrene and other plastic foams are now being used for making sandwich panels.

The useful strength of a honeycomb is virtually only that of the two skins, and it is important that these are chosen carefully. When the skins are held widely apart the moment of inertia is very high compared with a solid with the same weight. If, for instance, a strip of ¼ in steel plate were replaced by two skins of 16 swg steel sheet, these could be spaced at a distance of 12 in with a paper or aluminium honeycomb to give the equivalent weight; and the moment of inertia would be increased about 15,000 times. This fantastic increase would be attained with a lowering of lateral tensile strength to roughly a half, and the panel would take up far more room. But this basic idea does mean that materials like aluminium and reinforced plastics (with their lower moduli of elasticity compared with steel) can be significantly upgraded. Look, for practical examples, at the boat above, and the radar reflector and the textile machine platen below.

The two firms will offer honeycomb in different forms. Dufaylite manufacture honeycomb by a method in which the structure is made unexpanded by building up stacks of sheets with offset glue lines. This can be profiled in the compact form and is normally expanded by the user for commercial applications. This form of material is very convenient for transporting, but on the infrequent occasion when perfectly shaped cells are required, this expansion can be quite a tricky operation. Honeybombs are cut in all materials to a standard tolerance within ± 0·005 in.

***Profiled Sections.**—Already expanded honeycomb can be machined to profile. Far easier, though, in the absence of suitable milling machines, is the method of profiling before expansion. This is an aerofoil section in resinated Kraft paper similar to one used between aluminium skins for wings of the Jindivik aircraft (a pilotless jet aircraft used as high speed targets in guided weapon development).*



***Rigid radar reflectors.**—Cossor CR21 radar reflectors are 17 ft by 7 ft and are made from phenolic treated Kraft honeycomb. This is 3 in thick and has skins of glass reinforced polyester. With a total weight of 250 lb, the dishes distort less than ½ in in winds up to 100 mph. Others have been made with furane treated honeycomb and Durestos (asbestos filled phenolic) skins.*

***Impact absorption: aerial delivery.**—When overstressed, honeycomb panels normally fail by shearing of the core or in the skin. But when compressed across their depth, unresinated honeycomb can be made to collapse at almost constant yield stress, thus absorbing much energy with no rebound. Aerial delivery pad systems have been developed for loads of 10 tons.*

Maker	Base metal	Cell size, in	Density, oz per cu. ft	Compressive strength, lb per sq. in without skins	Price per sq. ft at 1 in thickness	Main skin materials	Makers' claims	Areas of application foreseen by makers
Dufaylite Developments Limited, Boreham Wood, Herts.	Resinated Kraft paper 0·005 in thick	¼–1½ ⅜ 1	45–8 30 12	270–420 112 30	5*s*–10*d* 1*s* 9*d* 1*s* 1*d*	Plywood, aluminium, steel, decorative laminates, glass reinforced plastic	"High strength to weight"	Aircraft interior panels, high quality laminates and (flat or single curvature reinforced plastic structures
	Furane treated Kraft paper, 0·005 in thick	⅜	40	180	3*s*	Asbestos filled plastic, glass reinforced plastic	"High wet strength and moisture resistance"	Radar aerials and other structures subject to climatic exposure
	Unresinated Kraft paper, 0·009 in thick	⅜–1½ ½ 1	36–10 25 14	40–12 30 12	9*d*–3*d* 6*d* 4*d*	Plywood, hardboard, plasterboard	"Intermediate price"	Furniture, panels, doors and general purpose laminates
	Cardboard, 0·015 in thick	1½	22	16	3*d*	Plywood, hardboard, plasterboard	"Low cost for mass production"	Flush doors and building-panels
	Glass fibre cloth, 0·005 in thick, impregnated with polyester	¼–¾ ⅜ ½	84–36 60 45	215–45 106 70	41*s*–15*s* 6*d* 20*s* 6*d* 17*s* 6*d*	Glass reinforced plastic . .	"Transparent to electromagnetic waves (radio, etc.), formable (before cured)"	Aircraft radomes and other electronic applications
	Cotton cloth, 0·005 in thick, impregnated with polyester	¼–¾ ⅜ ½	103–43 75 64	484–81 210 134	27*s* 6*d*–7*s* 6*d* 13*s* 9*s* 6*d*	Glass reinforced plastic	'Easily conforms to complex curvatures (before cured)"	Double curvature reinforced plastic structures such as marine hulls
	Aluminium foil (NS3), 0·003 in thick	⅜ ½ ¾	54 38 26	220 110 70	6*s* 4*s* 4*d* 3*s*	Aluminium, steel, glass reinforced plastic	"Metallic"	Aircraft and electrical industries
CIBA (ARL) Limited, Duxford, Cambridge	Aluminium foil (NS3), 0·003 in thick	¼ ⅜ (commercial)	91 61	428 240	8*s* 10*d* 7*s* 3*d*	Aluminium, steel, glass reinforced plastic	"Best all-round properties"	Two grades will be important commercially—see third column. The others are for aircraft use, for wing tips, fins and floors Commercial uses still feature high strength to weight ratio with rigidity such as for waveguides, platens, high strength car panels and floors
	Aluminium foil (NS3), 0·002 in thick	¼ ⅜ ½ (commercial)	126 64 42	910 262 145	13*s* 2*d* 7*s* 10*d* 6*s* 9*d*			
	Aluminium foil (NS3), 0·001 in thick	¼ ½	69 35	306 119	12*s* 4*d* 7*s* 6*d*			

Properties of honeycombs; the makers; and their comments.

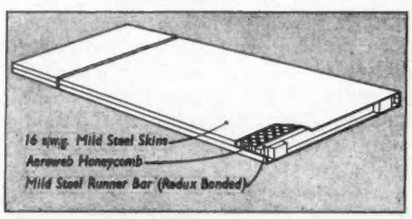
CIBA use another process in which the company pre-corrugate aluminium foil and glue these together. Cell shape is perfect, and CIBA have chosen to develop honeycombs using far smaller cells than Dufaylite. They can machine to the same tolerance as above and are not upset by the vagaries of cell expansion in making panels with complex curvatures (though not yet of real commercial importance). It could prove an expensive form to transport in large quantities over long distances, certainly more than the unexpanded variety.

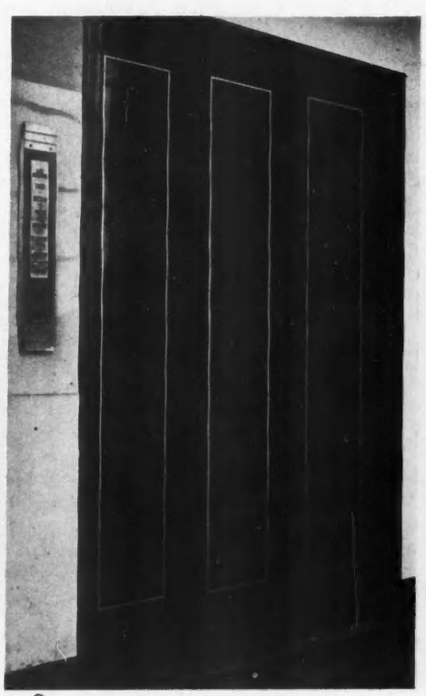
The crux of the matter to most people will probably be how easy it is to use the honeycombs. If it's any help, they are very similar in use to plastic foams. They need good adhesive technique to obtain bonds over the whole surface; and some thought is needed beforehand in putting spacer blocks and surrounding strips between the skins to take high local stresses and to give a tidy and weatherproof skin. But this is really the beginning and end; certainly there is no need to get bogged down in the special difficulties encountered in making complex curvature aircraft components.

Adhesives are made for any combination of honeycomb and skin. For aluminium to aluminium it will mean Redux adhesives and heat curing ovens, but for the others, cold setting ones will do since aluminium and steel skins can be bought ready-covered with a veneer which gives good adhesion. With glass reinforced polyester skins, the honeycomb can be pressed straight on to the inner side of the first skin while still wet. Polyester impregnated honeycombs of the Dufaylite type can be cured either before or after laying up the skins.

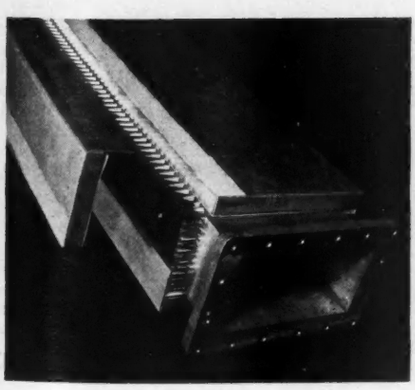
Aluminium honeycombs may appear the only honeycombs worthy of attention, but data in the table and these examples should show that technical properties which are almost as good and at much lower cost, can be obtained with ones based on paper. Care must be taken in choice for outdoor weathering and edge sealing must be effective, as is possible with reinforced plastic skins. So far as fire resistance is concerned, there is little to choose between the honeycomb materials as none of the inexpensive adhesives will remain strong in prolonged heat, and steps to lock the skin panels together mechanically against the eventuality can be taken no matter what is between the skins.

***Mirror-flat surfaces for doors.**—Otis Elevator Company are currently testing two lift doors made to this construction by CIBA from aluminium honeycomb. Weight saving here is not important and the outer skins are in mild steel. The great benefit is in reduction of surface distortion which can occur with spot welding. Labour costs are low and the surfaces—flat to 0·005 in—will take a mirror cellulose finish. If satisfactory, production could run into thousands of doors per year.*

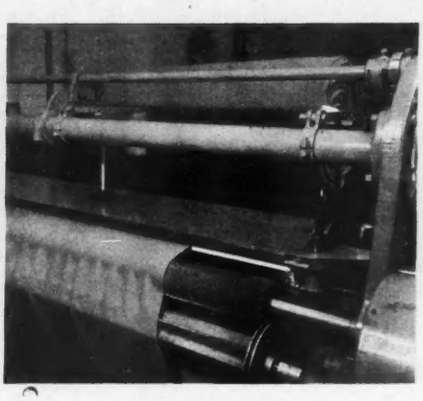




***Rigid and light waveguides.**—Aluminium honeycomb, as made by CIBA, has now been adopted as standard core material for pressurised waveguides made by Marconi at Gateshead. This illustration shows the skin construction. It is imperative that these are dimensionally stable in order to obtain guides with constant characteristics. Some withstand pressures of 40 lb per sq. in.*



***Increased speed with light platen.**—Pasolds of Langley have replaced cast iron platens with ones of aluminium honeycomb made by CIBA. This shows a 7 ft one on a textile napping machine, which weighs one-tenth the cast iron alternative. The new platens, faced with 22 swg aluminium and edged with wood can now be vibrated at two and a half times the old speed.*



Plain Words

By Capricorn

SOMETIMES I wonder if the most effective way of planning is to let things take their course and leave the sorting out to economics. Forget the future, abandon forecasting, but be quick in responding to all the winds of change. For want of a better phrase, I shall call it "planned mobility." Too bad it doesn't work.

How ready are we to slip from job to job when the economic climate changes? When the Government persists in laying on a credit squeeze to help the export drive, what are our reactions—yours and mine? Do we watch the squeeze gradually taking effect and forcing people to find employment in other industries, chuckle to ourselves and say "That's what we want. Get the men into the expanding industries and boost exports"? Of course we do—provided that it is the other fellow who feels the pinch, and we ourselves are sitting pretty.

Back in 1957 the aircraft industry was told it had to contract. Everyone talked about getting the industry's employment down by eighty thousand. Look at the employment figures today. They are even higher than before, and according to the latest reports actually growing. Some of the best brains in the aircraft industry have been devising ways of holding on to staff, and not simply by diversifying.

If you are a manager in the car industry do you sack your skilled workers because they are wanted in other industries? Not likely. You hang on to them like grim death for the day when the upswing comes. As for suggesting that salaried personnel should go, such an idea is positively uncharitable.

The transport industry, with its redundancies, is faced with one problem; the business equipment and computer industry, crying out for qualified and able men, with yet another. The power industry is largely self-contained, since to some extent it can balance its consumer swings against its capital-equipment roundabouts—and heavy power plant is in any case committed far ahead by the relatively fixed requirements of the power programme.

Each industry has virtually become an island, retaining its resources but redeploying them as the situation changes—or resorting to the tighter belt of short-time working. Unfortunately, it means that many of our brighter men are more concerned with keeping personnel than finding ways to export. We all defend our empires if we can.

We do it because we are trained to it. Unlike grandfather, who ran his own enterprise with an independence and decisiveness that gave flexibility, we all work on committees. We have become tactful and considerate, firmly united by the call to "do as you would be done by." Our pension schemes give us security and make it unworthwhile to move. Unpleasant, unexpected change is for other people, not for you and me.

Especially me. My plan for 1961 is sitting tight.

Letters to the Editor

The American Way

SIR, As a librarian employed as a "special" librarian by an industrial firm, I have been scanning issues of ENGINEERING for more than 25 years. I do not know just when your On the Shelf column started, but it seems that I have been reading it for several years.

I like the column but at least once in every four issues, I get very angry at Mr. Frank Smith's attitude towards Americans. He does not like us and very often ridicules our method of doing things.

About two years ago, when the man who is at the head of Aslib was in the United States, attending the Special Libraries convention, I asked him "why?" . . . he thought that I was mistaken and that it was just Mr. Smith's way of speaking or writing.

Very truly yours,
(MRS.) RACHEL MACDONALD.

Detroit 28, Michigan, USA.
30 December, 1960.

Editor's note.—We should like to refer our correspondent to the series of articles beginning with "I Like Americans" (ENGNG., 6 June '58, p. 712).

Losses by Railway Diesels

SIR, As I have been employed as an engineering-economist by a large American railway for the past five years, I read with interest the article entitled "Diesels Bring Losses to USA Railways" (ENGNG., 30 Dec. '60, p. 897).

I have the following comment to offer: It is essential to realise the difficulty in drawing specific meaning from a study of the type Mr. H. F. Brown has undertaken. His source data were statistics of the Interstate Commerce Commission, which necessarily lump together the hundred odd United States railroads, yielding global average figures. Due to the wide variation in operating characteristics found in America these global figures are usually virtually useless in making management decisions. The difference between British railway operation and that of many of the United States railroads is greater still.

This point is particularly well seen with regard to Mr. Brown's estimate of the steam power that would have been required had dieselisation not occurred. Such an estimate can only be made after detailed examination of individual railroads.

We must, therefore, decide that, although Mr. Brown may well have arrived at a correct conclusion, he has not offered sufficient proof in his paper, and more important, that this paper has little significant application to the situation on British Railways.

Yours truly,
G. A. COOPER.

Birmingham, 15.
12 January, 1961.

Technical College Libraries

SIR, Mr. Frank H. Smith's remarks about technical colleges in his recent On the Shelf article cannot go unanswered (ENGNG., 13 Jan. '61, p. 66). How do we outside the biggest cities get on, he asks, more particularly as regards the supply of periodicals.

In the first place, we *do* buy some. I can only speak for myself, but at this college we receive almost 200 periodicals regularly. This may seem rather small stuff to Mr. Smith, but at least it is a start. When anyone wants to see a periodical we do not possess, we try to borrow it for him and, in about 95 per cent of the cases, we succeed without any undue delay.

Where do we borrow from? We have access to the borrowing facilities of the Science Museum Library and the National Science Lending Library, and we also belong to Aslib. These three institutions take care of the majority of our requirements and, for the rest, we borrow direct from university, college and special libraries. Occasionally the chase is a long one, but we do not give up easily. Perhaps if Mr. Smith made a few more inquiries he would discover that our situation is far less desperate than he seems to think it is.

Yours faithfully,
D. L. HOULDRIDGE,
Librarian.

Medway College of Technology,
Chatham, Kent.
13 January, 1961.

Engineers on British Railways

SIR, Mr. J. Ratter (ENGNG., 18 Nov., '60, p. 672) takes Mr. Albu to task over his article "Modernisation Needs Modern Railwaymen" (ENGNG., 4 Nov., '60, p. 604), but in so doing he makes some strange statements.

His letter refers to "the quite remarkable technical success railway engineers have achieved." This might be fair comment were British Railways leading in the technical field but in actual fact almost all developments in this country are no more than copies of what has been done abroad years ago. Indeed most of the new locomotives and rolling stock suggest that not nearly enough use was made of existing knowledge in their design stages. No doubt this aspect is covered by Mr. Ratter's statement that "of course some mistakes have been made."

It is not true to say that the majority of the staff, being engaged on traffic duties, have nothing to do with engineering. Running a railway is mainly an engineering operation and the productivity of the whole organisation is determined largely by the ratio of qualified engineering staff to total staff. It is surprising to find that Mr. Ratter, who is the senior technical officer on British Railways, apparently does not share this view. Most engineers will see a strong connection between the prevalence of his type of thinking and the fact that, even after £900 million has been spent on "modernisation," British Railways' gross receipts for 1959 averaged under £1,000 per employee (excluding works staff engaged on new construction). The situation is akin to a present-day civil engineering contractor relying on navvies with wheelbarrows instead of modern earth-moving machinery. The really disturbing factor is that far too much of the Modernisation Plan equipment bears a closer resemblance to an improved wheelbarrow rather than an up-to-date piece of contractors' plant.

It is doubtful if there are more than 30 university graduates employed on the mechanical side of British Railways with more than 12 months' experience subsequent to their two year training period. There is already ample evidence that British Railways must be at least as well-informed technically as their suppliers, if really progressive reliable equipment is to be produced, for the George Stephenson tradition, referred to by Mr. Albu in the House of Commons is not peculiar to British Railways' own engineers. When purchasing equipment, no railway can afford to rely on a manufacturer's assurance that it has worked well in, say, Australia; all types must be thoroughly assessed and intelligently tested before acceptance. To properly carry out this and other work connected with the development and operation of such equipment, British Railways is likely to need more graduates than the firms responsible for the actual designing and not, as Mr. Ratter says, fewer.

There are two main reasons for the shortage of graduates. Their pay while training has been raised to a level competitive with that elsewhere, but the same does not apply to the salaries they can expect upon promotion. In consequence there is little financial incentive to continue with British Railways and the high rate of wastage was mentioned in the Select Committee Report. The main trouble, however, is as Mr. Albu infers

—frustration. There seem to be too many cases where good work counts for little, either because of the inadequate standards of their seniors, or because the whole project is ill-conceived. For example, it is hardly encouraging for a graduate working on traction equipment for the new electric expresses for the Dover line to find that their average speed will be a mere 42 mph, instead of the 70 mph obviously necessary if the railway is to survive in the age of motorways.

No, Sir, Mr. Albu did not go too far. He did not go far enough.

Yours faithfully,
G. W. FENTON.

Newcastle upon Tyne.
19 January, 1961.

Using Hair for Packaging

SIR, May we draw your attention to the article entitled "Hair is a New Packaging Material" (ENGNG., 30 Dec. '60, p. 878), which concerns our products ?

We feel that your article is a little confusing. Tuflite, which was manufactured by Xetal Products Limited, was no different to other products except that it used a plastic bonding agent. Texlite continues to use rubber as the bonding agent but exploits a special new principle which you have referred to as "a three dimensional structure," but which, in our trade, is more generally referred to as a crimped structure.

Texlite and Tuflite are in no way similar, and bear no comparison, either of visual, chemical or dynamic examination; they are two entirely different products.

We believe that if you check with Xetal Products Limited, Liverpool, or better still, with their parent company, the Dunlop Rubber Company Limited, you will find that they have ceased to trade.

Yours faithfully,
P. M. HOWARD,
Director.

The Hairlok Company Limited,
Bedford.
6 January, 1961.

Plastic Lined Reservoirs

SIR, With reference to the article entitled "Plastic Films Seal Storage Ponds" (ENGNG., 9 Dec., '60, p. 787), your readers may be interested in the accompanying illustrations of plastic-lined reservoirs taken near Salt Lake City, Utah, in May, 1960.

Fig. 1 shows a completed plastic-lined reservoir with a capacity of 15 acre-ft (equivalent to about four million gallons). The film used is 800 gauge pvc (0·008 in), and the plastic is protected by a layer of "back-fill" material placed on top of it.

Fig. 2 shows the construction of a five million gallon reservoir which is to be lined with plastic film. The wall slope must not be greater than about three horizontal to one vertical—if this slope is exceeded the covering material tends to slide to the bottom.

Yours faithfully,
HENRY R. SPICE.

Islip, Oxfordshire.
12 January, 1961.

Events in Advance

Urban Survival and Traffic

MUCH attention is necessarily being directed at the present time to the increasing influence of traffic requirements upon the layout of new towns and the replanning of towns already in existence.

In order to provide an opportunity for those professionally engaged on urban redevelopment in connection with architecture, traffic control, and planning the use of land, to study the interaction of these activities, the University of Durham has arranged to hold an international symposium. It will have as its general theme "Urban Survival and Traffic" and will be held at King's College, Newcastle upon Tyne, from 10 to 14 April next. The organisers are the departments of architecture, civil engineering, and town and country planning of the university, in collaboration with the Roads Campaign Council.

In addition to the official opening of the conference in the afternoon of 10 April, there will be a conversazione in the evening of that day. Lectures and, in some cases, study groups will take place on the following three days. An official dinner will be held on 13 April and the closing session will be held on the morning of 14 April. Technical films will be shown in the evening of 12 April.

Also on 12 April, delegates will be taken for a study tour in Durham, where they will be shown road and redevelopment proposals and the use of television for purposes of traffic control. In this connection, it may be mentioned that the Durham City Council have made plans for the comprehensive redevelopment of their city centre, which, it is estimated, will cost something in the region of £3 million. In conjunction with the county council, the city council have drawn up proposals for two new bridges over the Wear, a new through road, office blocks and a really modern shopping centre.

The symposium will be residential and delegates may stay at Eustace Percy Hall, accommodation being available in single rooms for both men and women, at a charge of 30*s* a day, inclusive of breakfast, supper and gratuities. The fee for the course will be £9. This fee will cover attendance, preprints of papers available in advance, *proceedings* (to be published in book form and to include all papers submitted, whether read at the conference or not), the study tour and the official dinner.

Those presenting papers to the symposium will include experts in their particular fields from Britain, Australia, Germany, Spain, South Africa and the United States. Applications to attend should be made not later than 15 March and all communications respecting the event should be addressed to Dr. T. E. H. Williams, Department of Civil Engineering, King's College, Claremont Road, Newcastle upon Tyne, 2.

Exhibitions and Conferences

Dublin Spring Show and Industries Fair.—Tues., 2 May, to Sat., 6 May, in Dublin. Organised by the Royal Dublin Society, Ball's Bridge, Dublin.

Packaging Exhibition, International (MACROPACK).—Tues., 2 May, to Tues., 9 May, at Amsterdam. Organised by N. V. Raedthuys, 5 Tesselschadestraat, Amsterdam-Z., Holland.

British Columbia International Trade Fair, Second.—Wed., 3 May, to Sat., 13 May, at the Exhibition Park, Vancouver. Additional information obtainable from the general manager, 1961 British Columbia International Trade Fair, Exhibition Park, Vancouver, BC, Canada; or the Agent General, British Columbia House, 1-3 Regent Street, London, SW1. Tel. WHItehall 6857.

United States World Trade Fair, Fifth.—Wed., 3 May, to Sat., 13 May, at the Coliseum, New York. Open to trade and public. Organised by the Charles Snitow Organization Inc., 331 Madison Avenue, New York. United Kingdom Agents: Trade Fairs and Promotions Ltd., Drury House, Russell Street, London, WC2. Tel. TEMple Bar 3422.

Central African Trade Fair and Exhibition.—Wed., 3 May, to Sun., 14 May, at the Agricultural Society's Showground, Bulawayo. Apply to the development officer, P.O. Box 1776, Bulawayo, Southern Rhodesia.

Swedish Industries Fair, 44th International.—Sat., 6 May, to Sun., 14 May, in Gothenburg. In the United Kingdom, applications should be made to John E. Buck and Co., 47 Brewer Street, Piccadilly, London, W1. Tel. GERrard 7576.

Sports Goods, Camping Equipment and Garden Furniture; International Fair of (SPOGA).—Sun., 7 May, to Tues., 9 May, in Cologne. Inquiries in the United Kingdom should be sent to Mr. Neven du Mont, 123 Pall Mall, London, SW1. Tel. WHItehall 8211.

Industrial Finishes Exhibition and Convention, First International.—Mon., 8 May, to Thurs., 11 May,

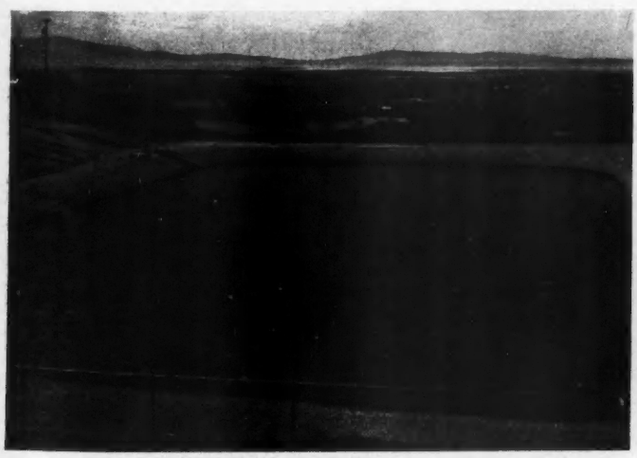


Fig. 1 Completed plastic-lined reservoir of 15 acre-ft near Salt Lake City. The Great Salt Lake can be seen in the background.

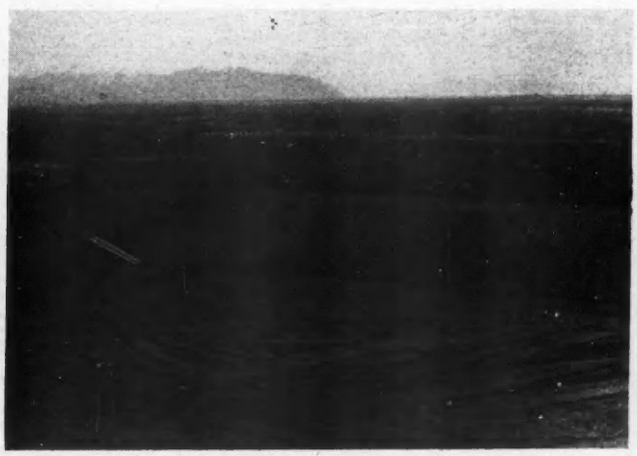


Fig. 2 Showing the construction of a five million gallon reservoir prior to the installation of the plastic membrane, later covered with backfilling.

at Earl's Court, London, SW5. Organised by Scientific Surveys Ltd. (Exhibition Division), 97 Old Brompton Road, London, SW7. Tel. KNIghtsbridge 9360.

Office Exposition, International.—Mon., 8 May, to Thurs., 11 May, at Kiel Auditorium, St. Louis, Missouri, USA. Organised by the National Office Management Association. Apply to the Field Service Division, NOMA, 1927 Old York Road, Willow Grove, Penn., USA.

Production Show, National Industrial.—Mon., 8 May, to Fri., 12 May, at the Industry Building, Exhibition Park, Toronto. Forms and further information are obtainable from Mr. E. M. Wilcox, National Industrial Production Show of Canada, 19 Melinda Street, Toronto, Ontario, Canada. A British display is being organised and inquiries regarding it should be sent to Mr. A. J. Cox, general manager, the Birmingham Exchange and Engineering Centre, Stephenson Place, Birmingham 2. Tel. Midland 1914.

Footwear, Leather and Machinery Exhibition.—Wed., 10 May, to Tues., 16 May, in Pirmasens. Organised by Messeamt der Stadt Pirmasens, 19 Dankelsbachstrasse, Pirmasens, Germany.

Meetings and Papers

British Institution of Radio Engineers

LONDON
"Perseus: A Medium-Scale Data-Processing System," by G. Emery. Computer Group. London School of Hygiene and Tropical Medicine, Keppel Street, WC1. Wed., 8 Feb., 5.30 p.m.*

CARDIFF
"Principles of Analogue-to-Digital Computer Conversion," by J. L. W. Churchill. South Wales Section. Welsh College of Advanced Technology, Cardiff. Wed., 8 Feb., 6.30 p.m.

EDINBURGH
"Measuring Stability and Spurious Modulation Spectra of High-Quality Oscillators," by A. L. Whitwell. Scottish Section. Department of Natural Philosophy, The University, Drummond Street, Edinburgh. Wed., 8 Feb., 7 p.m.

GLASGOW
"Measuring Stability and Spurious Modulation Spectra of High-Quality Oscillators," by A. L. Whitwell. Scottish Section. Institution of Engineers and Shipbuilders in Scotland, 39 Elmbank Crescent, Glasgow, C2. Thurs., 9 Feb., 7 p.m.

Chemical Society

BRISTOL
"Discovery and Development of Terylene," by J. R. Whinfield. Bristol Branch. Department of Chemistry, The University Bristol. Thurs., 2 Feb., 6.30 p.m.

CAMBRIDGE
"Mobile Stereochemistry of Nitrogen," by Dr. K. Schofield. Cambridge Branch. University Chemical Laboratory, Lensfield Road, Cambridge. Fri., 10 Feb., 8.30 p.m.

PORTSMOUTH
"Silicones: Their Properties and Industrial Applications," by A. N. Tizard. Southampton Branch. College of Technology, Portsmouth. Wed., 8 Feb., 7 p.m.

East Midlands Metallurgical Society

DERBY
"Modern Production and Metallurgy of Blackheart Malleable Cast Iron," by H. Greatorex. Derby and District College of Art, Derby. Thurs., 9 Feb., 7.30 p.m.

Illuminating Engineering Society

SHEFFIELD
Presidential Address, by W. S. Stiles. Sheffield Centre. Grand Hotel, Sheffield. Mon., 13 Feb., 6.30 p.m.

Institute of Information Scientists

LONDON
"Language at the Interface of Technology and the Law," by F. W. Cousins. Swedenborg Society Hall, 20 Bloomsbury Way, WC1. Wed., 1 Feb., 6.15 p.m.*

GLASGOW
"The Future of the Institute," by C. W. Hanson. North British Hotel, Glasgow, C3. Sat., 4 Feb., 10.30 a.m.

Institute of Metals

GLASGOW
"Beryllium as a Structural Material," by Dr. A. J. Martin. Scottish Local Section. Institution of Engineers and Shipbuilders in Scotland, 39 Elmbank Crescent, Glasgow, C2. Mon., 13 Feb., 6.30 p.m.*

SWANSEA
"Inspection of High-Strength Wrought Aluminium Alloys," by W. Smitham. South Wales Local Section. Metallurgy Department, University College, Singleton Park, Swansea. Tues., 7 Feb., 6.30 p.m.*

Institute of Physics and the Physical Society

LONDON
"Tunnel Diodes": Symposium. Joint meeting with the British Institution of Radio Engineers, at 47 Belgrave Square, SW1. Tues., 7 Feb., 2.15 p.m. (Tickets required.)

Institute of Road Transport Engineers

GLASGOW
"Recent Developments in Head Lighting," by Dr. J. H. Nelson. Scottish Centre. Institution of Engineers and Shipbuilders in Scotland, 39 Elmbank Crescent, Glasgow, C2. Mon., 6 Feb., 7 p.m.

HOVE
"Air Suspension," by J. Sainsbury. Southern Centre. Palmeira Hotel, Hove. Wed., 8 Feb., 7.30 p.m.

NOTTINGHAM
"Vocational Training in the United Kingdom and Overseas," by H. S. S. Brown. East Midlands Centre. Mechanics' Institute, Nottingham. Wed., 8 Feb., 7.30 p.m.

Institution of Chemical Engineers

LONDON
"Science and the Developing Countries," by P. M. S. Blackett. Hinchley Memorial Lecture. Geological Society, Burlington House, Piccadilly, W1. Wed., 15 Feb., 5.30 p.m.

Institution of Electrical Engineers

BIRMINGHAM
"Development of High-Voltage Air-Break Circuit Breakers with Insulated-Steel Plate Arc Chutes," by F. S. Fay, J. A. Thomas, D. Legg and J. S. Morton. South Midland Centre. James Watt Memorial Institute, Great Charles Street, Birmingham 3. Mon., 6 Feb., 6.30 p.m.*

EDINBURGH
"A Visit to South Africa," by Professor M. G. Say. South East Scotland Subcentre. Carlton Hotel, Edinburgh. Tues., 7 Feb., 7 p.m.

LEEDS
"Application of Electronics to the Electrical Supply Industry," by Dr. J. S. Forrest. Third Hunter Memorial Lecture. North Midland Centre. Leeds and County Conservative Club, South Parade, Leeds 1. Tues., 7 Feb., 6.30 p.m.*

Institution of Engineering Designers

NEWCASTLE UPON TYNE
"Precision Investment Casting," by N. Walker. North East Branch. Rutherford College of Technology, Northumberland Road, Newcastle upon Tyne. Mon., 6 Feb., 7.15 p.m.

Institution of Engineers-in-Charge

LONDON
"Process Steam Utilisation," by W. N. Barber. Caxton Hall, off Victoria Street, SW1. Wed., 8 Feb., 6.30 p.m.*

Institution of Engineers and Shipbuilders in Scotland

GLASGOW
"Modern Machine Tools and Production Methods": discussion. Tues., 14 Feb., 6.30 p.m.

Institution of Heating and Ventilating Engineers

LONDON
"Planning of Engineering Services for a Hospital," by K. Stead and B. T. Rose. Institution of Mechanical Engineers, 1 Birdcage Walk, St. James's Park, London, SW1. Thurs., 9 Feb., 6 p.m.*

CARDIFF
"High-Velocity Air-Conditioning Systems," by J. Cuthbert. GEC Building, Cardiff. Tues., 7 Feb., 6.30 p.m.

Institution of Highway Engineers

LEEDS
"Design and Execution of Road Improvements in Urban Areas," by S. G. Wardley. Yorkshire and Lincolnshire Branch. Griffin Hotel, Leeds. Thurs., 2 Feb., 7 p.m.

Institution of Mechanical Engineers

LONDON
"Influence of Measuring Force, Stylus Radius and Surface Finish on the Accuracy of Measurement of Work Pieces by a Comparator," by L. W. Nickols and T. R. J. Oakley; and "An Investigation into the Accuracy of Industrial Measurement of Sizes Between 0·02 and 5 in," by P. W. Harrison. Wed., 8 Feb. 6 p.m.*

Institution of Plant Engineers

LONDON
"Standards in Plant Engineering," by Dr. E. L. Diamond. Royal Society of Arts, John Adam Street, Adelphi, WC2. Tues., 7 Feb., 7 p.m.*

BRISTOL
"Foundry Development," by D. Potts. Western Branch. Grand Hotel, Broad Street, Bristol. Wed., 8 Feb., 7.15 p.m.

GLASGOW
"Use of Gas in Industry," by R. W. Deans. Glasgow Branch. Scottish Building Centre, 425 Sauchiehall Street, Glasgow, C.2. Thurs., 9 Feb., 7.15 p.m.

NOTTINGHAM
"Problems in the Design of Rocket-Engine Test Beds," by R. H. B. Forster and L. Breen. East Midlands Branch. County Hotel, Theatre Square, Nottingham. Wed., 8 Feb., 7 p.m.

PETERBOROUGH
"National Dialling Systems," by Lieutenant-Colonel W. E. Gill. Peterborough Branch. White Lion Hotel, Church Street, Peterborough. Tues., 7 Feb., 7.30 p.m.

Institution of Production Engineers

LONDON
"The Function and Scope of Modern Materials Handling," by W. G. Rumble. London Graduate Section. Wed., 15 Feb., 7.15 p.m.

COLCHESTER
"Further Training of University Graduates with Particular Reference to Production Engineering," by S. H. Potter. Ipswich and Colchester Section. Davey, Paxman and Co., Ltd., Canteen, Britannia Works, Colchester. Fri., 10 Feb., 7.30 p.m.

DARLINGTON
"A Consultant's Role in Industry," by Alan Beeton. Tees-side, Section. College of Further Education, Cleveland Avenue, Darlington. Tues., 7 Feb., 7 p.m.

Institution of Public Health Engineers

LONDON
"Modern Composting Methods and Controlled Tipping, by C. H. Smith. Caxton Hall, off Victoria Street, SW1. Thurs., 16 Feb., 6 p.m.

Institution of Structural Engineers

LONDON
"Aluminium Strut Design," by J. B. Dwight. Thurs., 9 Feb., 6 p.m.*

BELFAST
"Concrete Bridge Design," by L. Clements. Northern Ireland Branch. Civil Engineering Department, David Keir Building, Queen's University, Belfast. Tues., 7 Feb., 6.30 p.m.

MIDDLESBROUGH
"The Channel Crossing: Bridge or Tunnel," by J. F. Pain. Northern Counties Branch. Cleveland Scientific and Technical Institution, Middlesbrough. Tues., 7 Feb., 6.15 p.m.

Junior Institution of Engineers

LONDON
"Measurement of Nuclear Radiation," by G. G. Ballard. Fri., 10 Feb., 7 p.m.*

Leeds Metallurgical Society

LEEDS
"Metals in Antiquity," by Dr. R. F. Tylecote. Metropole Hotel, Leeds. Tues., 7 Feb., 6.30 p.m.*

Liverpool Engineering Society

LIVERPOOL
"Vyrnwy Aqueduct Booster Pumping Station," by D. C. Summerton. Central Library, William Brown Street, Liverpool. Thurs., 9 Feb., 7.30 p.m.

Liverpool Metallurgical Society

LIVERPOOL
"Origin and Solution of Some Industrial Corrosion Problems," by E. C. Campbell. Department of Metallurgy, The University, Liverpool. Thurs., 9 Feb., 7 p.m.

Manchester Metallurgical Society

MANCHESTER
"Residual Stress and Stress Relieving," by Dr. L. E. Benson. Manchester Literary and Philosophical Society, George Street, Manchester. Wed., 8 Feb., 6.30 p.m.

Reinforced Concrete Association

BIRMINGHAM
"Concrete Construction in Russia," by Cyril V. Blumfield. Midland Counties Branch. Birmingham and Midland Institute, Paradise Street, Birmingham. Tues., 7 Feb., 6 p.m.*

MANCHESTER
"Lift Slab Design and Construction," by F. R. Benson. North Western Branch. College of Technology, Sackville Street, Manchester. Tues., 7 Feb., 6.45 p.m.*

Royal Aeronautical Society

LONDON
"An Appreciation of Missile Structures," by A. F. Newell. Astronautics and Guided Flight Section. Tues., 7 Feb., 6 p.m.

Royal Institution

LONDON
"Diamonds," by Sir Gordon Sutherland. Fri., 10 Feb., 9 p.m.

Royal Society of Arts

LONDON
"The Timber Industry," by Rodney Perry. Wed., 8 Feb., 2.30 p.m.

Sheffield Metallurgical Association

SHEFFIELD
"Ion Exchange: Its Development, Significance and Use for Ferrous Analysis," by Dr. V. E. Gripp. BISRA Laboratories, Hoyle Street, Sheffield. Tues., 7 Feb., 7 p.m.

Society of Instrument Technology

LONDON
"The Universal Decision Element," by Professor J. E. Parton and A. Rose. Manson House, 26 Portland Place, W1. Mon., 6 Feb., 7 p.m.*

BIRMINGHAM
"Process Control," by R. M. J. Withers. Midland Section. Gosta Green College of Technology, Aston Street, Birmingham. Fri., 10 Feb., 7 p.m.*

CHELTENHAM
"Instrumentation at Berkeley Power Station," by F. J. Benstead. Cheltenham Section. Belle Vue Hotel, Cheltenham. Thurs., 9 Feb., 7.30 p.m.

LIVERPOOL
"Flame Failure Equipment," by A. M. Lock. Liverpool Section. Industrial Development Centre, Manchester and North Western Electricity Board, Liverpool. Thurs., 9 Feb., 7 p.m.

Television Society

LONDON
"Transistorised Distribution Amplifiers," by B. Marsden. Cinematograph Exhibitors' Association, 164 Shaftesbury Avenue, WC2. Fri., 10 Feb., 7 p.m.

Women's Engineering Society

LONDON
"Space Flight": Discussion. Hope House, 45 Great Peter Street, SW1. Wed., 8 Feb., 7 p.m.*

The address and telephone number of the headquarters of each institution are given below. Meetings in the headquarters town are held there unless otherwise stated. An asterisk (*) is placed where it is understood that refreshments are available prior to the time stated.

British Institution of Radio Engineers, 9 Bedford Square, London, WC1. (MUSeum 1901)
Chemical Society, Burlington House, Piccadilly, London, W1. (REGent 0675)
East Midlands Metallurgical Society. Apply to Mr. E. D. Knights, 10 Penrhyn Avenue, Derby.
Illuminating Engineering Society, 32 Victoria Street, London, SW1. (ABBey 5215)
Institute of Information Scientists. Apply to Mr. J. Farradane, Torran, Croft Road, Orpington, Kent.
Institute of Metals, 17 Belgrave Square, London, SW1. (BELgravia 3291)
Institute of Physics and the Physical Society, 47 Belgrave Square, London, SW1. (BELgravia 6111)
Institute of Road Transport Engineers, 69 Victoria Street, London, SW1. (ABBey 6248)
Institution of Chemical Engineers, 16 Belgrave Square, London, SW1. (BELgravia 3647)
Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, WC2. (COVent Garden 1871)
Institution of Engineering Designers, 38 Portland Place, London, W1. (LANgham 8847)
Institution of Engineers-in-Charge, 13 Grange Close, Edgware, Middlesex. (MILl Hill 3543)
Institution of Engineers and Shipbuilders in Scotland, 39 Elmbank Crescent, Glasgow, C2. (Central 5181).
Institution of Heating and Ventilating Engineers, 49 Cadogan Square, London, SW1. (SLOane 3158)
Institution of Highway Engineers, 47 Victoria Street, London, SW1. (ABBey 3891)
Institution of Mechanical Engineers, 1 Birdcage Walk, St. James's Park, London, SW1. (WHItehall 7476)
Institution of Plant Engineers, 2 Grosvenor Gardens, London, SW1. (SLOane 0469)
Institution of Production Engineers, 10 Chesterfield Street, London, W1. (GROsvenor 5254)
Institution of Public Health Engineers, 179–181 Vauxhall Bridge Road, London, SW1. (VICtoria 3017)
Institution of Structural Engineers, 11 Upper Belgrave Street, London, SW1. (SLOane 7128)
Junior Institution of Engineers, Pepys House, 14 Rochester Row, London, SW1. (VICtoria 0786)
Leeds Metallurgical Society. Apply to Dr. P. R. Beeley, The University, Leeds.
Liverpool Engineering Society, 9 The Temple, 24 Dale Street, Liverpool 2. (Central 3717)
Liverpool Metallurgical Society, Greenhithe, Grosvenor Road, St. Helens, Lancs. (St. Helens 5879)
Manchester Metallurgical Society, The Kennedy Press, Ltd., 31 King Street West, Manchester 3.
Reinforced Concrete Association, 94-98 Petty France, London, SW1. (ABBey 4504)
Royal Aeronautical Society, 4 Hamilton Place, London, W1. (GROsvenor 3515)
Royal Institution, 21 Albemarle Street, London, W1. (HYDe Park 0669)
Royal Society of Arts, John Adam Street, Adelphi, London, WC2. (TRAfalgar 2366)
Sheffield Metallurgical Association, 64 Crescent Road, Sheffield 7. (Sheffield 52865)
Society of Instrument Technology, 20 Queen Anne Street, London, W1. (LANgham 4251)
Television Society, 166 Shaftesbury Avenue, London, WC2. (TEMple Bar 3330)
Women's Engineering Society, 25 Foubert's Place, London, W1. (GERrard 5212)

What's Happening in the Outside World

Durability is coming to American cars, and countries not normally accepted as major car producers are entering the market.

By Gordon Wilkins

THE motor shows at Brussels, New York and Minneapolis will bring together the full range of the 1961 American cars which were not all on view in Paris, London or Turin. An interesting aspect of these cars is the emphasis American manufacturers are placing on durability after years of concentrating on artificially created obsolescence. They do not all go as far as American Motors who promise that their new Rambler compact car will not be subject to "capricious" annual style changes, but a warranty of twelve months or 12,000 miles is now general and American Motors have even extended it to cover 1960 cars still in their guarantee period.

On many of the large models, chassis lubrication is already abolished by use of rubber or nylon bushes or bearings with sealed-in lubricant. Ford, Mercury, Lincoln and Cadillac all offer this inducement. For steering ball joints, Ford use a grease containing molybdenum disulphide retained by polyurethane seals.

CERAMIC SILENCERS

An item on American cars which frequently deteriorates very fast is the silencer and efforts are being made by several manufacturers to prolong its life. American Motors, for example, use a ceramic coated silencer and tail pipe guaranteed for the life of the car. The ceramic is fused to the metal at 1,500° F and further protection is provided by a covering of asbestos on the silencer retained by a zinc coated steel outer jacket.

Problems of easy entry into low built cars still occupy designers and the latest Ford Thunderbird has a "swing away" steering wheel which recalls the hinged wheel of the first Mercedes 300SL coupes. The column has a universal joint at the lower end and the wheel can be swung aside through 10 in, guided in a curved rack just below the instrument panel. These cars now have automatic transmission as standard and the column can only be moved with the gear selector in the Park position. The engine can be started but the car will not move away until the column is returned to the driving position.

More examples of mechanical complication imposed by stylists are to be found on the Lincoln Continental. On the four door convertible, the rear doors are hinged on the rear face. This apparently retrograde move is countered by a vacuum operated system which locks all doors when the car is on the move. To make it easier to get into the rear seats on the coupé, rear quarter windows retract 6 in when a rear door is opened.

Ford are pushing quality as a sales argument on this car. The engine will be run for three hours on the bed and the automatic transmission for 30 minutes. Both will then be stripped and rebuilt before installation in the car. All wiring is checked with an electronic circuit tester, and each car is spray tested for body leaks. A lubricant leakage test is made with fluorescent fluid, and finally there is a road test of 12 miles with a check list of 200 items.

With the work now being done on the production of light alloy V8 engines, primarily for the compact cars, 1961 seems likely to see the end of the cast iron engines of 5 or 6 litres for the big cars too. Buick, Oldsmobile, Pontiac and Chevrolet already have light alloy engines on their compact cars. The Buick water cooled engine is said to weigh only 318 lb, which is about 200 lb less than the cast iron engine in the big Chevrolet, previously America's lightest production V8. Unwilling to take too many risks, General Motors did not go to full die casting for their block, with the attendant problems of open water jackets and high tooling costs. They use a permanent mould system with steel moulds and sand cores. Wet cylinder liners were rejected on grounds of cost and poor rigidity. Cost also ruled out inserted dry liners or chromium plating of light alloy bores and machining of eutectic alloys proved a problem, so they use cast-in iron liners with ribbed outer surfaces to give a good mechanical bond.

American Motors have applied a full die cast block to an existing six cylinder engine. The water jackets are open at the top and sealed by a special gasket. They, too, use cast-in iron liners with a roughened exterior to give a firm bond. Weight of the block is said to be 59 lb against 139 lb for cast iron, cutting the weight of the engine to 380 lb.

Among the new American transmissions, the most interesting is the new Buick Special two-speed which obtains forward and reverse motions with only one planetary gear set. Reverse is obtained by redistributing functions among the elements of the fluid torque converter. The turbine is locked stationary and the stator is connected by a clutch to the rear wheels. It rotates in the opposite direction to the turbine to give reverse motion. More clutches are needed, but they are cheaper to make than gears. The result is a light compact transmission, said to weigh only 96 lb. Another feature of this year's transmission is the use of a split drive between converter and gear train, an arrangement which seems to be gaining favour.

European manufacturers revealed all their new models at the autumn motor shows, but Citroen have just announced a slight face lift for the little 2 CV. The corrugated bonnet has been replaced by a neater panel above a smaller cooling air grille.

NEWS FROM THE EAST

Russia now seems to have got the Zaporozhets baby car into production. It is a solidly built two-door model with a high ground clearance and weighs 1,320 lb.

Prototypes of this car had a flat-four engine which seemed to be a scaled down Volkswagen but this got covered in mud on Russian roads. The production engine is an air cooled V4 of 748 cc mounted at the rear. To solve the balance problems inherent in this design, the balance weights on the crankshaft are supplemented by a gear driven contra-rotating shaft with balance weights at each end, which runs at crankshaft speed inside the hollow camshaft. The engine retains the Fiat-type centrifugal oil filter inside the fan pulley.

China is building up a motor industry but is not yet ready to consider a peoples' car. The Red Flag limousine, now in production, is a car of conventional design with V8 engine of 5·6 litres giving 220 bhp and an automatic transmission. The next model for production seems to be the Peace, also a large V8 limousine with superficial exterior resemblance to the Chevrolet of 1958.

The Japanese motor car industry is not being left behind. Though some of their products appear to owe a certain amount to Western designs, Japanese engineering being as good as it is, this can be regarded as flattery rather than anything else. Some idea of the quality of their work can be gathered from one of the accompanying illustrations which shows one of the latest Japanese cars—the Nissan Cedric. This six seater with a 1,488 cc ohv engine has a reported top speed of approximately 82 mph. It has a four speed gear box with synchromesh on 2nd, 3rd and top gears. The car measures about 14 ft 6 in long by 5 ft 8 in wide and has a wheelbase of 8 ft 3 in.

Poland is still improvising. Their main production is concentrated on the Warszawa, formerly the Russian Pobieda. Chassis parts from this are also used in the rather heavy small car, the Syrena with a two stroke engine. The Syrena factory has recently built a rather attractive prototype of a sports coupe powered by two Junek motor cycle engines of 349 cc coupled together to give 32 bhp. A four speed gearbox is used and suspension is by torsion bars.

(*Left*) *The Citroen "deux chevaux" has had a face lift.*

(*Right*) *The Japanese "Cedric" has a pleasing appearance and performance to match.*

Better Backing for Small Firms' Ideas

Financial backing for new ideas often presents a problem to the small firm. For most engineering projects, the best way to obtain such backing is through the National Research Development Corporation.

INDUSTRIAL experience over the years has shown that research pays. That is, in general it pays, though in many specific cases it does not. The overall average shows a credit balance but individual cases sometimes show a loss.

This means that to the individual, especially the small man, there is always an element of risk in sinking money into research. Since development, production and marketing costs must all be added before a research project can reach commercial maturity, a great deal of money may be needed before an invention can be exploited. Nowadays, development costs can be as much as a hundred, or more, times the cost of research.

With large firms this may not present an insurmountable problem. For instance, the General Electric Company were able to invest something like £2 million on transistor research and development before a profit margin was reached. However, with smaller firms evolution of a new idea may have to be retarded, or even shelved, for years because of lack of available funds.

It is in cases such as this that the National Research Development Corporation is not only able, but positively keen, to be of assistance—provided that the development in question is in some way in the national interest.

Of course, capital for a really good project can be obtained in several ways and, all other things being equal, it would not appear to matter where the money comes from. But, in the case of engineering research and development, all other things are not equal—financial backing from NRDC is accompanied by at least three additional assets.

(1) The NRDC are able to thoroughly vet a new idea or invention by drawing on their committee of advisors, many of whom are world-class experts in their field. They are also in an excellent position to obtain industrial and commercial advice to ensure that the invention, however ingenious it may be, as a good *commercial* proposition.

(2) As experts in establishing new inventions, the NRDC are able to offer good advice and legal-procedure facilities in establishing (and possibly contesting) patents.

(3) Backing from NRDC also lends prestige to a project and often results in some useful publicity.

The National Research Development Corporation is a statutory body, set up in 1949 by the Board of Trade under an Act of 1948. It is not a government department and its executives are not civil servants. Its board includes a chairman, a full-time managing director, a full-time deputy managing director and a full-time executive member. There are also eight part-time members, all of whom hold important positions in science and industry.

The Corporation's job is prescribed in two Acts of Parliament. The Act of 1948 gave them the function of developing and exploiting inventions derived from research "carried out by a government department or other public body," or any research "in respect of which financial assistance is provided out of national funds."

Their current portfolio contains over 3,000 United Kingdom and overseas patents and applications for inventions, the majority of which were made in government research establishments, the Medical Research Council, the Agricultural Research Council, the universities and the hospitals. There are, of course, certain exceptions. The Corporation does not concern itself with inventions designed solely for purposes of defence, nor with inventions for which the United Kingdom Atomic Energy Authority and the nationalised industries are responsible.

For inventions from any other source, the 1948 Act states that the development must be in the public interest and must not be under development elsewhere.

By a subsequent Act in 1954, the Corporation was empowered to promote and assist research of a specific character, namely, "research for satisfying specific practical requirements where the Corporation is of the opinion that the research is likely to lead to an invention"; also, "to assist the continuation of research where it appears that a course of research has resulted in any discovery which in the Corporation's view may lead to inventions of practical importance."

As a consequence, NRDC's job is broadly divided into two types of activity:

Exploitation—exploitation of patent rights for those inventions which have reached the Corporation in a form sufficiently advanced for more or less immediate introduction into industry, and Sponsorship—sponsoring of projects either for the development of inventions already in being or for research designed to produce inventions to meet specific needs. It may also be for the continuation of existing research.

ADDITIONAL POWERS

Finance for the Corporation's activities can be obtained in two ways. Firstly, they can obtain interest-bearing loans from the Board of Trade. These must not at any time exceed £10 million, and the present statutory terms within which these loans may be made will expire in 1969. Secondly, the Corporation is in continuous receipt of revenue from licence agreements, from recovery arrangements made with industrial firms, from once-for-all payments received as consideration for the assignment of patent rights, and from the sale of assets from a project.

Insofar as it can be done consistently with the fulfilment of their purposes, the Corporation's financial returns must be "sufficient to meet their outgoings on revenue account." This need for establishing a balance of its accounts is not always readily reconcilable with the requirement that the corporation shall always act in the public interest, but it does mean that they must watch the commercial prospects of a venture.

Wherever possible, financial support for a new project is coupled with an arrangement for recovery of NRDC's outlays, plus a profit. If a venture fails, the NRDC investment is lost.

Making development pay without having any "bread and butter" lines of manufacture means that the Corporation has to rely completely on patent royalties and similar recoveries in order to secure a return on its activities.

This is really a crucial point, because it means that money spent on an unsuccessful development cannot lightly be written off to experience, as it often is in industry. The original assessment therefore must be exceptionally thorough.

Identification of projects may result from approaches made to the Corporation on the initiative of individual inventors, research establishments or firms. It can also be made when the Corporation itself takes the initiative in examining the needs of industry. One of their major problems is to maintain a continuous liaison with centres of research and industry.

While relations with government research establishments, research associations and universities are now well established, a full awareness of the NRDC's value in connection with project development is not apparent among individual firms. In industry, the NRDC seems to be better known for its work in exploiting patent rights than for assisting development. Curiously, the private inventor appears to be better informed—submissions from private inventors (from the UK and overseas) far outweigh those from industrial firms.

This situation has shown some improvement over the last twelve months, but is still not generally satisfactory. A better understanding of the facilities offered by NRDC would in many cases be of benefit to industry as a whole.

Over the eleven years of its life, the Corporation has sponsored many developments in widely varying fields, though the specific arrangements it has made in any one case have rarely been paralleled in another. It is therefore almost impossible to give a clear account of the mechanism by which they do help. In some cases they have given straight development contracts to suitable firms in industry. In other cases they have set up and financed companies specifically to handle the new idea, or have financed an existing company who have, in turn, set a development company. Again, the NRDC has sometimes collaborated in joint ventures with firms.

This shows that the Corporation is, as indeed it must be, extremely flexible in its working. Any reasonable proposal, as long as it comes within the Corporation's terms of reference, will be judged on its merits—regardless of precedent. Thus the door is wide open to industrial firms, big or small, for all forms of scientific or engineering development.

During its eleven years, the NRDC have sponsored a very wide range of engineering ideas. One of the most famous in recent years has been the Dracone collapsible oil barge (illustrated) which offers revolutionary advantages for the sea transportation of bulk oil.

Human Element

Making the Best Use of Manpower

"In a changing world there is still a reluctance to change."

Thus the British Employers' Confederation advising industry to make one of its principal objectives for 1961 the fully efficient use of manpower.

We can no longer afford, in a world where competition grows more and more keen, to employ three men on a job which can safely and reasonably be done by two, says the Confederation in its bulletin. Neither, if three men are needed, can we afford to restrict the intake so that only two are available.

Putting it like this the BEC is in fact speaking to both the unions and the employers. In certain, particularly craft, unions, fears of unemployment and falling wages have led to long established policies of restricting the intake of new men. Now that it is being learnt that failure to be fully competitive can lose people their jobs much more surely than any possibility of there being too many men in the market, there is some hope that the trade union leaders are carrying their members with them in their efforts to bring about more zeal for better productivity.

It is still necessary for the BEC to observe, "yet there are many who still cherish the view that increased productivity means fewer jobs and harder work for those who remain."

Holding on to Men

On employers' practices, the BEC says "With an eye to demand increasing and production rising, many employers much prefer to keep their work force intact on short time rather than disband teams which work well together and to face the difficulties of recruiting when recruitment becomes difficult."

The BEC recalls the figure of 365,063 unemployed and the number of unfilled vacancies, 293,905.

It is true that very many of the unemployed are unskilled workers and that a high proportion of the unfilled vacancies are for skilled or semi-skilled people. It is also true that the areas in which the most unemployed and most vacancies occur do not exactly coincide.

But the unfilled vacancies figure suggests that an opportunity for retraining exists and that labour immobility is a serious factor.

17,000 More in Employment

A rise of 55,000 in the number working in the distributive trades, and falls in motor industry employment, in agriculture and construction, led to an overall increase of 17,000 in the working population in Britain during November. The new total was 23,839,000.

There were 1,783,000 people working overtime in manufacturing industries in the last complete week in November, an improvement of 70,000 over the level of last August. At the same time there were 126,000 operatives on short-time work, 31,000 more than in October and 95,000 more than at the end of August. Two-thirds of those on short time were in the motor industry.

Between October and November the numbers engaged in the engineering and electrical goods industries of the Ministry of Labour classification rose from 2,101,000 to 2,107,000. Shipbuilding and marine engineering numbers rose from 246,000 to 247,000.

The drop in agriculture in the same period was 25,000 and in construction 10,000.

More Short Time in the Motor Industry

Continuing depression in car sales is still producing effects spreading beyond the borders of the car makers and their marketing organisations. At Wolverhampton, a thousand employees of the Wolverhampton Die Casting Company have gone on to a four-day week because of the conditions in the car industry, which is the outlet for between 40 and 50 per cent of the firm's output.

The company employs a total of 2,500 people. The night shift, already on a four-day week, will continue unchanged.

At Dagenham, where the Ford Motor Company is putting 16,000 of its 45,000 workers on a three-day week, the shop stewards have come out in favour of full five-day pay whatever the length of the working week. The shop stewards declare that they are—"entitled to a share in the golden profits we have made for the company over the years."

A swift meeting between the national leaders of the unions which have members at Fords and the company has also been urged by the shop stewards. This request had been anticipated by union officials on the National Joint Ford Negotiating Committee who have now met the management representatives.

Short-time working, the facts on car demand behind the reduction to a three-day week, and the introduction of three-shift working to a relatively small part of the great Dagenham works were all discussed at the meeting.

£5 Cut Suggested

At Coventry, where the car plant men of Standard-Triumph International work a three or four-day week, the company put forward the suggestion that, in order to keep down the price of a fresh model with a larger engine the higher-paid men should voluntarily drop £5 in their wages and lower-paid men about £3. On the full time which a successful new model would bring, the higher-paid men would be drawing, without the cut, about £23 a week, and the lower-paid employees £17 or £18.

Price level is a factor which has sometimes been linked with the technically-advanced Triumph Herald and in any new model, whether from Standards or any other firm, the price would be an extremely important factor at a time of all-round difficulty in sales.

The suggested pay cut at Standards would not operate until the five-day week is again in operation and apparently it is not intended to go into production with the changed model until those conditions have returned.

Early reaction from the shop stewards suggested that, while the expected references to profits were being made, there was a strong body of opinion which prefered a smaller pay packet to the possibility of none at all. But a shop steward meeting unanimously vetoed the suggestion.

A more cheerful but certainly challenging note comes from Jaguar also at Coventry. Sir William Lyons, the chairman and managing director, brought the whole 5,000-worker plant to a stop and spoke by loudspeaker to the waiting workers.

"You have got to earn the firm's revenue," he told them. "It is quality that sells cars and we have all got to work together as one team to get that." The company is delivering record numbers of cars.

Notices around the Jaguar plant proclaim—"Quality sells cars" and "Bad workmanship will not be tolerated."

Demand at Bottom

In a time when the amount one dealer will allow off the price of one new car compared with another salesman and the relationship between the trade in price of a used car and the cost of the new one being bought are standard subjects of conversation, it is noticeable that the Jaguar models are quoted as exceptions to these practices.

Vauxhall Motors, at Luton, whose chairman, Mr. Philip Copelin, has constantly reiterated to his staff his belief that the demand has hit bottom and who believes that the industry's historic pattern of renewed demand from February onwards need not fail this time, have had to tell their workers that the continued depression has worsened the employment position.

Cost Saving Awards at Vauxhall Motors

The Vauxhall Motors' suggestion scheme, introduced as a war-time measure and now an important part of the company's method of running the plant, paid out six maximum awards of £450 each last year for cost saving suggestions. Twenty-six awards of £100 or more were also given.

A total of £13,649 was paid during the year for 1,004 successful suggestions out of the 5,159 considered. The year before the amount paid had been rather smaller, £11,854, for slightly more successful suggestions, 1,094.

The passenger car trim line section won the shield for the factory area with the best suggestions record for the second year in succession.

Lower Speeds and Fewer Road Deaths

So many other factors affect road safety that it is hard to believe there will ever be a clear decision on the effects of speed on the road casualty figures.

If there had not been a sharp fall in the rate of road deaths in Britain over the five days of Christmas it would have been possible to come more quickly to a conclusion on the results of the Swedish experiment in which, for 19 days, the speed limit was 48 miles an hour.

During the 19 days the number killed fell to 23 from 54 in a similar period a year ago. The number of road accident injuries was reduced in the same degree. Over the Christmas holiday there were two deaths instead of the eleven at the 1959 Christmas.

Considerable resistance to the assumption that the saving in life is due to the reduced speed limit is reported from Swedish motorists. Ice and snow, they argue, would have kept speeds down, restrictions or not, and specially safe driving is said to have followed the persistent warnings over radio and television. November's costly toll of road deaths is also said to have resulted in greater care.

A second look at these arguments shows that in the main it is the reason for the slower driving and not the fact that it was slower that is being disputed. Perhaps this is some indication of the validity of effective speed restriction in limiting road casualties.

A Special Course in Industrial Oil Hydraulics

Stein Atkinson Vickers Hydraulics Limited are adding to their normal programme of courses in hydraulics a special three-day course in Industrial Oil Hydraulics, to be held in Belfast, Northern Ireland, from 1 to 3 March.

The three categories of Stein Atkinson's courses are

1. The hydraulics installation and maintenance course. This deals with the servicing and setting up of hydraulic equipment, emphasising trouble spotting, valve construction, pipework and care of the fluid.
2. The hydraulics equipment course. This describes the range and operation of equipment sold by the company as well as the description of general hydraulic principles and ancillary components.
3. The hydraulics application course. Dealing with the design approach to hydraulic problems; this course includes the building and development of circuits.

The Belfast course will combine 1 and 2 and is being offered for service engineers and designers. The prospectus and applications forms are available from the schools secretary at Stein Atkinson, Vickers Hydraulics, 197 Knightsbridge, London, SW7.

Glasgow Professor to be New Economic Adviser

Alexander Cairncross, Professor of Applied Economics in the University of Glasgow, is to be the new Economic Adviser to the Government, from 1 June, this year.

One of that select band of pre-war lecturers on economics who went into the Civil Service during the Second World War and reached senior positions, Professor Cairncross became Director of Programmes at the Ministry of Aircraft Production. From 1946 to 1949 he was economic adviser to the Board of Trade and from then until 1950 economic adviser to the Organisation for European Economic Co-operation.

He has occupied the Applied Economics chair at Glasgow since 1951. Professor Cairncross will be returning to the Civil Service at a time when economic advice to the authorities could hardly be more important. Not the least of the problems on which the new Economic Adviser will have some effect will be the delicate business of balancing advancing economic growth with the need to do better on the balance of overseas trade, and also Britain's position in relation to the European Free Trade Association and the economically stronger European Common Market.

High Living Standards from Cheap Power

New Zealand is blessed with abundant water power and cheap electricity. Projects under construction include some of the largest in the southern hemisphere.

NEW ZEALANDERS use electricity freely, their rate of domestic consumption being the highest in the world. Of the country's power output, 60 per cent is used in homes. From ample water power the country is able to generate electricity cheaply, and much of New Zealand's high standard of living is due to an inexpensive supply of power.

The New Zealand Electricity Department owns 90 per cent of the country's generating capacity and handles bulk transmission and sale. Major generating stations within each of the two main islands are linked by 1,100 miles of 220 kV high tension lines. Another 4,233 miles of transmission lines distribute power at between 33 kV and 110 kV to local authorities who sell it

Location of three of the principal hydro-electric schemes.

to users. The power supply system at the end of 1959 is shown in the accompanying map. In all but a few remote localities, electricity at 230 volts ac is used for lighting, cooking, heating, labour-saving devices and radio sets. It also operates milking, cream separating and sheep shearing machines on farms, and has greatly hastened the expansion of manufacturing industry. No large electro-chemical industries yet exist though several are under active consideration.

The public electric supply system has cost £252 million (or £109 a head of population). Its installed generating capacity is 1·4 million kW, 86 per cent of which is water driven; and the total generated in a year is 5,677 million kWh. The rate of generation per head of population is 2,712 kWh, which places New Zealanders among the first six in the world as users of electricity.

It costs 0·427*d* on an average to generate 1 kWh of electricity (0·34*d* for hydro-electric and 1·48*d* for thermal power). The average retail price is 1·424*d*, but charges vary considerably among local authorities, and industrial and domestic customers are supplied at different rates.

The North Island has two-thirds of the population but it has less than half the estimated hydro-electric generating potential. Attempts to redress this imbalance include investigation and development of geothermal power using steam from subterranean bores to drive generators (see ENGNG., vol. 187, 1959, p. 398), and an investigation is in hand of the practicability of feeding surplus electricity from the South Island by submarine cable carrying 500 kV direct current under Cook Strait to the North Island.

The capacity of state-owned generators in the North Island was (at March, 1960) 1,032 MW, including 180 MW from a coal-burning station at Meremere and 69 MW from the first stage geothermal installation at Wairakei. Most of the hydroelectric output comes from two complexes —one of five stations on the Waikato River and the other of three stations fed from Lake Waikaremoana. On the Waikato River, which is fed by Lake Taupo, three more major stations are being built to bring capacity to over a million horsepower, and a duplicate project to boost the peak load capacity of an existing station is under construction. Work has begun on a 70 MW station on the Rangitaiki River in the Bay of Plenty area; development of the Wanganui River is being studied. Investigations are proceeding into the practicability of diverting the headwaters of rivers rising on the western side of the central mountain range into Lake Taupo on the other side, generating power at new stations *en route* as well as augmenting the output of existing stations on the Waikato.

In the South Island at the same date nine State-owned stations had an installed capacity of 390 MW, of which 265 MW came from the Waitaki and Clutha rivers. At Roxburgh on the Clutha, New Zealand's biggest existing station, capacity is being raised to 320 MW; and on the Waitaki the construction of Benmore, a 540 MW project, has begun. A scheme to use lakes in Fiordland to generate perhaps a million kW for an industrial company to use in electrolytic smelting of Australian aluminium ore is being investigated.

Early Beginnings

The first recorded use of water power to generate electricity in New Zealand was in 1885 when the Phoenix Quartz Mining Company installed a Pelton wheel on the Shotover River in Otago. Established in 1887, the Reefton Electric Lighting Company was one of the first public suppliers of electricity in the Southern Hemisphere. In 1888, the Gulcher Light Company opened two stations in Wellington which used water from the city mains to generate power. Other early public hydro-electric supplies were: Stratford Borough, 1898; Patea Borough, 1901; and Tourist Department, Rotorua, 1901. The first large power station was the 6·3 MW plant opened in 1913 at Horahora on the Waikato by the Waihi Gold Mining Company.

From 1896 onward various minor legislation on water power was enacted. In 1903 the first major legislation, the Water Power Act, reserved to the Crown the rights to use natural water flow for public supply of electricity, and to license persons and companies to use water power. Public opinion became increasingly in favour of the State itself developing hydro-electric resources. This led to the passing in 1910 of the Aid to Water Power Works Act, which authorised the raising of £500,000 for electrical works. The first project, the 4·5 MW supply for Christchurch from Lake Coleridge, was started in 1911 by the Public Works Department. The hydro-electric branch of the public works department constructed, maintained and operated electric generation and distribution facilities until 1945 when a separate organisation, the State Hydro-electric Department, since renamed the Electricity Department, was created. The Ministry of Works, as it is now called, still investigates, designs and carries out the civil engineering construction of new generating stations, but it does this to the overall requirements of the Electricity Department, which designs and instals electrical equipment and transmission lines. The Electricity Department operates eighteen hydro-electric, one geothermal steam, three coal or oil-fired steam and several small diesel stations, as well as the national supply network.

Waikato

The Waikato River, the longest in New Zealand (220 miles), drains Lake Taupo in the centre of the North Island. Lake Taupo lies at 1,210 ft altitude, has an area of 238 square miles, a depth of 534 ft and a catchment area of 1,250 square miles. To make full use of the fall of the Waikato, nine generating stations have been built or are under construction, as shown in the sketch map opposite. Proceeding upstream the state of development at September, 1960, was: Karapior 90 MW; Arapuni 158 MW; Waipapa (scheduled for 1961) 51 MW; Maraetai 180 MW (being duplicated to 360 MW); Whakamaru 100 MW; Atiamuri 84 MW; Ohakuri (scheduled for 1961) 112 MW; and Aratiatia (1964) 90 MW. These projects are spaced along 90 miles of the river.

All the early dams were built of concrete, but some of the later ones, namely Waipapa and Ohakuri, are earth filled. Many unusual problems have been met in the Waikato Valley, especially in consolidating dam foundations into country faulted by siesmic action. It took 2½ years to drive a diversion tunnel, 1,688 ft long, to take the full flow of the river before dam building at Maraetai could begin. Hydro-electric developments brought many incidental benefits to the Waikato area: roads built to dam sites now serve previously inaccessible land; lakes formed by dams are proving useful in many ways—the 15 miles long lake formed by the 170 ft high Karapiro dam has become a scenic asset with fishing and boating; a town, Mangakino, has grown out of a construction base camp.

The 180 MW thermal station at Meremere was built as an emergency measure at a time when electricity consumption was leaping ahead of the rate of hydro-electric construction. It is fired with coal brought by rail and aerial cableway from nearby open-cast mines.

Geothermal Project

In November, 1958, the use of geothermal steam to generate electricity began at Wairakei near the northern shore of Lake Taupo. Several years of exploratory drilling proved the existence of extremely large quantities of subterranean steam. At present, Wairakei is being carried out in three stages. The first is complete and seven generators are now producing more than 60 MW. Work has begun on the second stage which is expected to produce 83 MW. The third stage should increase the scheme's overall output to approximately 250 MW.

The Wairakei project is the only geothermal-electric scheme in the Commonwealth and the second in the world. Development has been complicated by unusual problems in the separation of steam from water, which have been solved, and prolonged but not unexpected difficulties with turbine rotors. Exploratory drilling in the vicinity of Wairakei is continuing.

A second field of geothermal steam, at Waiotapu, has also been under examination in recent years. Drill holes to depths of 3,360 ft have shown that the geological formation at Waiotapu are different to those at Wairakei. At the latter place, ignimbrite underlies about 2,000 ft of breccias and extends downwards more than 4,000 ft, while at Waiotapu four ignimbrite sheets alternate with sedimentary rocks and breccias. The maximum temperatures at Waiotapu are higher than at Wairakei, and so are the shut-in wellhead pressures. Though the measured output from one bore at Waiotapu equalled

the average at Wairakei, from a second the output was noticeably less.

In the eastern interior of the North Island three hydro-electric stations are driven by water from Lake Waikaremoana and were opened in 1929, 1944 and 1948. Their combined output is 124 MW. Mangahao, 70 miles from Wellington, the oldest Government-owned station in the North Island, has been operating since 1925 and has a capacity of 19·2 MW.

New Sources

In the North Island, the earlier hydro-electric stations and the two large thermal stations provide most of the baseload capacity while a proportion of hydro-electric generators recently or soon to be commissioned will increase the peak load capacity. Sources of new power for the North Island after 1965 have still to be decided. Construction of a 72 MW station at Matahina on the Rangitaiki River began in mid-1960. The first power from this Bay of Plenty project is expected in 1965. Development of the hydro-electric potential of the Wanganui, the second longest river in the North Island, is being investigated. The results of these investigations will not be known till mid-1961. The hydro-electric potential of a number of smaller North Island rivers is also being investigated.

By 1965, when stations at present under construction should be completed, the power of the Waikato River will be fully employed. A scheme is being investigated to augment the flow of the Waikato by diverting into Lake Taupo some of the headwaters of rivers rising on the western and south-eastern slopes of the range, which includes Mounts Ruapehu, Ngauruhoe and Tongariro. The diverted waters would also generate additional electricity on their way to Lake Taupo. Underground conditions are being investigated, and rainfall, snowfall and flow of rivers on the western and south-eastern slopes measured.

The consulting engineers investigating the scheme have proposed that it be divided into two parts. One would divert the headwaters of the south-flowing Rangitikei River northward through a chain of tunnels and reservoirs and two power stations into the Tongariro River and ultimately to Lake Taupo. The second part would divert the headwaters of the Wanganui River and its tributaries, which rise on the western side of the range, into Lake Taupo, through tunnels, lakes, aqueducts or shallow channels, and existing rivers. A power station would be built at Tokaanu near the southern end of the lake.

If put into practice, the Upper Waikato scheme will resemble the Snowy River Scheme in Australia in that it will divert water from one side of a mountain range to the other. It would have some most impressive engineering works (one tunnel would be nine miles long).

South Island Stations

Geological conditions for dam building are better in the South Island and, because proved hydro resources are ample and well distributed, generating stations are widely dispersed. (On the Waitaki River the two operating stations are Waitaki and Tekapo, as shown in the project map below. Waitaki, commissioned in 1935, has a capacity of 105 MW. Tekapo, opened in 1951 and producing 25 MW, is at the outlet from Lake Tekapo, one of the three lakes feeding the Waitaki River.

Construction work in progress for the earth dam at Benmore, which will be one of the largest in the Southern Hemisphere. On the far bank are the diversion tunnels and on the near side can be seen the shoulders for the two temporary cofferdams which were subsequently completed during 1960. The excavation in the foreground is for the watertight core for the main dam.

Construction of Benmore, the third station on the Waitaki, is advancing well, and a progress photograph of mid-1960 is reproduced above. This 540 MW project, the largest so far attempted in New Zealand, will first produce power in 1965. Its most striking feature will be an immense earth dam, one of the largest south of the Equator. The permanent coffer dams are now complete; both have watertight cores and the core trench for the main dam is open down to the bedrock. Super-elevated roadways have been built suitable for 70 ton scrapers operating at speeds of 30 to 35 mph; separate sealed roads have been laid for lighter traffic.

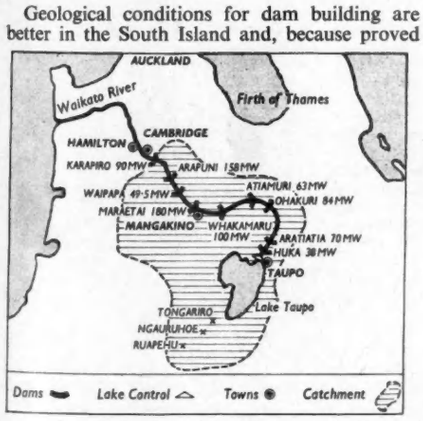
As on the Waikato, where a township called Mangakino was created to house construction workers, their families and the people supplying their needs, a town has been established at Otematata near the Benmore project. Otematata has single men's quarters as well as 525 houses for married men. Its facilities include cinema, newspaper and hospital. It will also house workers for a proposed project at Aviemore, between Benmore and Waitaki.

Schemes to develop further stations in the Waitaki Basin above Benmore are being investigated. One would involve linking Lakes Tekapo, Pukaki and Ohau with the Waitaki River by canals.

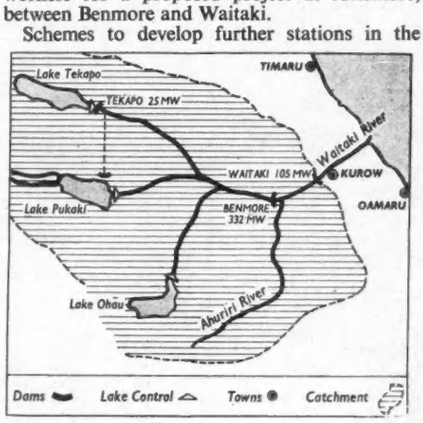
Roxburgh, on the Clutha River (see site map below) produces 160 MW from four machines. Four more machines, now being installed, will double the output. Another dam, at the outlet from Lake Hawea into the Clutha River, has raised the level of the lake by 65 ft and provided storage to offset the low winter flow.

At the junction of the Cobb and Takaka Rivers in Nelson Province a generating station has been operating since 1944. Begun by a private company and completed by the Government, the Cobb River Scheme now produces 32 MW. Coleridge, at the outlet of the lake of the same name, 63 miles from Christchurch, was completed in 1915 and was the first large power station built by the Government. Its capacity is 34·5 MW. Monowai (6 MW), fed by Lake Monowai in Southland, and Arnold River (3 MW), near Greymouth, were purchased by the Government from local power boards in 1936 and 1938. At the end of an irrigation canal connecting the Rengitata and Rakaia Rivers in Canterbury is Highbank power station. Opened in 1945 it generates 25 MW.

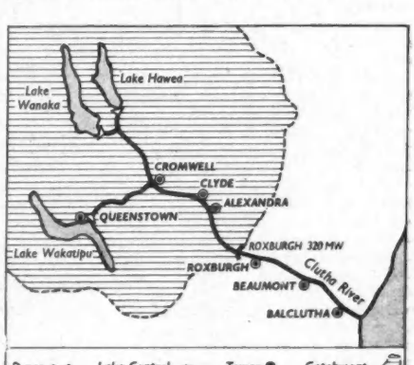
The Electricity Department also operates standby diesel stations at Stoke, near Nelson, and Dobson, near Greymouth. A number of towns, cities and power boards also operate generators, and there are three small privately owned stations on the West Coast.



Waikato River development (1,180 MW).



Waitaki River development (1,600 MW).



Clutha River development (1,140 MW).

These three site plans indicate completed and proposed river works in the areas.

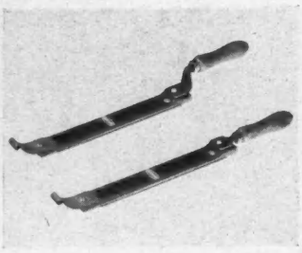
CUTTING TOOL

Sturdy Industrial Version

Now coming on the market is an industrial version of the Surform cutting tool.

This new tool brings the Surform range up to 10 including the original plane, file, round file, disc and drum. The working surface of the industrial tool consists of a " blue blade " of hardened and tempered steel set with numerous angled teeth. Although similar in principle to the existing blade, the teeth have been set at a different angle and are somewhat closer together. It is coloured blue for identification.

Another change is that the body is now made of steel. This has improved the strength so that there is no fear of breakage from rough handling in the factory. Two forms of handle are available as shown in the illustration. One is straight and the other cranked to suit certain applications. Both can be fixed straight in line as shown or can be set at various angles when awkward corners have to be reached. The cranked handle can even be set to lie over the blade.



The front hand rest is removable, again for access.

All parts of the tool are available separately (with the exception of the body itself) and all are interchangeable. Prolonged tests have been carried out on prototypes both in the maker's works and in users' shops. One tool was subjected to tests on a Herbert file testing machine and working at the rate of 55 strokes per minute cut off 49 in of 1 in by 1 in mild steel in 82,000 strokes, each 6 in long. Working load was 24 lb. The tools are said to be especially suitable for hard materials, including glass fibre. *Firth Cleveland Tools Limited, 7 Cleveland Row, London, SW1.*

PHONE SYSTEM

For Pressurised Suits

Now on the market is a communication system for use with pressurised suits.

The equipment consists of a power supply, a personal set and a control console if required. Power can be drawn from batteries or from the mains, and a standby set is available to guard against mains failure. The personal set is contained in a plastic-coated steel canister measuring approximately 4 $\frac{1}{16}$ in by 2$\frac{1}{8}$ in by $\frac{15}{16}$ in. There are two controls, one for volume and the other for background noise. Both control the outgoing signal only. The circuit is such that the sender receives his own transmission, which tends to stop operators interrupting while listening to a communication and enables a constant check to be kept on the serviceability of the set.

The control console is capable of supplying up to 10 slaves. Direct communication between any slave and the master is possible at any time and any slave can be in touch with any other.

The master can speak to a slave by using the console or by simply plugging in another set. The headsets are of the Government-approved boom microphone type and are fully weatherproof. Large rubber ear pads attenuate to a large degree any external noise. *Spembly Limited, Chatham, Kent.*

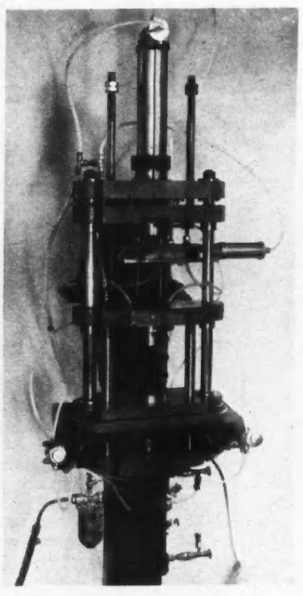
PIN INSERTER

2½ Second Cycle

Dowel pins are fed and inserted automatically by a new machine now on the market.

The machine is designed for repetition work and the model illustrated will handle two pins simultaneously. Other versions can be supplied for inserting any number at once. The pins are fed from a Syntron vibratory bowl and are taken by tubes to the breech mechanism. This transfers them to the holes in the work clamp tool.

Components are placed on guide pins and the two push buttons depressed to bring the lower sliding bolster down under air pressure to clamp the work. At the bottom of the stroke a pneumatic valve is operated to bring the dowel pins into place, resting on the spring loaded pilot pins. The impact cylinder the nbrings the upper bolster down and punches the pins in position. The cycle takes about 2½ sec and the floor to floor time depends on the number of components to be joined. *Rhoden Partners Limited, 19 Fitzroy Square, London, W1.*



COOLER

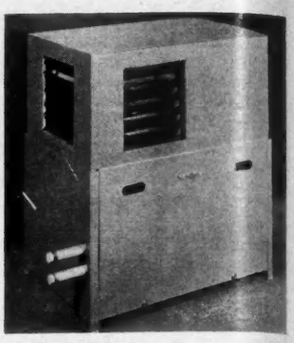
For Machine Tool Cutting Oils

Most liquid coolants can be cooled in the illustrated self-contained unit which is now generally available.

The design was primarily intended for cooling cutting oils on machine tools such as borers, grinders and honers, but most liquids for industrial processes can be handled including water.

A hermetically sealed motor compressor unit using Refrigerant 12 is the power source and with it are a finned air cooled condenser and propeller fan, a receiver and strainer-drier, the complete set of units being mounted on a common base plate.

Access to the condenser unit is obtained by unscrewing two nuts and removing the upper cover. The lower half of the unit houses the cooling coil which is of the tube-in-tube type; the liquid to be cooled being circulated over a coil of evaporating refrigerant. A pocket is fitted in the liquid outlet for the thermostat phial, the actual temparature of the liquid being controlled automatically. Units are supplied ready for



installation, the only connection required being for the flow and return.

The unit is wired for normal power supplies, and is fitted with a starting relay and safety switch. The only maintenance required is occasional cleaning of the condenser and fluid circuit, the frequency depending on local conditions. The unit is available in two sizes to cool either 5 or 10 gallons per minute. The compressor carries a five year guarantee. *L. Sterne and Company Limited, 158 North Woodside Road, Glasgow, NW.*

MOBILE CRANE

240 ft Boom

Now being imported into this country are the Lorain lorry mounted cranes type MC-85.

These machines have booms which can be extended to 240 ft and can handle up to 3,600 lb at 120 ft radius when the outriggers are in place. Alternative booms are 50, 95, 140 and 200 ft long.

The carrier is based on a single piece alloy steel casting with mounting plate, mounting pads, and outrigger boxes cast integrally. The length is 31 ft and the wheel base 198 in. Power is provided by a 262 hp engine giving ten forward speeds from 0·5 to 20 mph. The load is controlled by a two-lever joystick from a Caterpillar D337F diesel engine driving through a torque convertor. The Sheerball crane mounting is used which is without centre pin or turntable rollers.

The booms are all welded tubular throated type construction made in high tensile steel. A high tilting and folding gantry provides for eight parts of derricking line, and when in the lowered

position the overhead clearance is no more than cab height. *Vales Plant Register Limited, 14 Lower Grosvenor Place, London, SW1.*

SCREWDRIVER

Torque Controlled Clutch

A " MAGNAMATIC " clutch is incorporated in the air driven screwdriver and nutrunner type CP-LMS-1600.

The clutch is formed by a magnet housed inside a pair of mating cylindrical jaws. At one end, the jaw cylinder is tapped to accommodate the threaded shank of the cylindrical magnet which fits inside the jaws while at the other end is a steel disc. The jaw teeth are curved in shape, the depth to which they interlock being governed by the number of turns made in the magnet shank. When the set torpue is reached the jaws disengage, the lower being held out of engagement by a latch which is released when the tool is withdrawn.

The driver is equipped with a lever handle and has nominal capacity for screws up to No. 8. Torque adjustment is from 5 to 20 lb-in on soft pull up, with up to 40 lb-in at sudden stop. The tool length is 10 in and the weight 1 lb 14 oz. *Consolidated Pneumatic Tool Company Limited, 232 Dawes Road, London, SW6.*

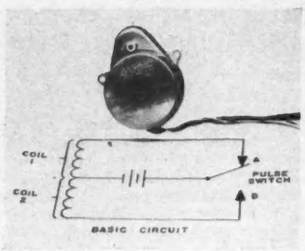
STEPPING MOTOR

Electromagnetic

NO MECHANICAL ratchets, electrical contacts, or commutator are needed in a new low voltage stepper motor.

The series 18100 motor is thin and small, and is very quiet in operation. It may be operated with the windings continuously energised on static condition or pulsed at rates up to 2,400 steps per minute. As the windings have a low L/R ratio the motor is suited for high speed applications where the pulse power is limited. Shock loads of 100*g* for 7 milliseconds can be withstood as well as accelerations up to 10*g*. Temperature operating range is from — 54° C to + 85° C. Pulse requirements are 12·5 milliseconds minimum.

If one coil of the motor is energised, the rotor will advance 15° when the switch is transferred to the next position, energising the second coil. Returning the switch to the first position will again energise the first coil and advance the rotor another 15°, so completing one pulse cycle. Thus both coils must be



energised alternately to obtain rotation; consecutive pulses to one coil will not cause the rotor to move. Control circuitry is facilitated since a switch in either pulse lead may be used to interrupt the pulse source and prevent rotation. Positive magnetic detenting occurs at each of the 12 angular positions, whether or not the coils are energised.

Magnetic shielding is good owing to the iron stator, and the small size allows two units to be used to give bidirectional movements. The continuous duty rating is 27V dc and the torque is 0·28 oz-in at 20° C. *A. W. Haydon Company, Waterbury, Connecticut, USA.*

WATER SAMPLER

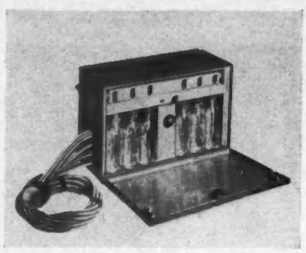
Automatic Operation

UP TO 12 water samples can be taken over a period of time by a unit now on the market.

Twelve 20 oz sample bottles are contained in a case that also houses the controls. Each bottle has a separate tube connecting to a common collecting head. Initially each bottle is evacuated by a pump and the pinch valve on the tube closed. The valve is held closed magnetically and can be opened by a pulse from the power supply.

A 15-day clockwork motor times the intervals at which the valves are successively opened, power being supplied by a 6V lantern battery. At each interval a condenser is discharged through the coil of the stepping rotary switch advancing the selection by one position. This at the same time causes the coil of the pinch valve to receive a pulse opening the valve and allowing a water sample to be drawn into the corresponding bottle.

The complete unit measures 24 in long by 15 in high by 10 in wide, and is provided with carrying handles at each



end. Each of the long sides forms a door which is hinged at the lower edge exposing six bottles and their control switches. On one side is also the central control panel which includes the period selector providing for one sample to be taken every 1, 2, or 4 hours; the manual winder for the time clock; and an on-off switch that initiates the sampling cycle.

The carrying case is constructed of mild steel with an outer shell of aluminium. It is kept watertight by the use of neoprene sealing gaskets on the doors, and stands on rubber feet. *Elcontrol Limited, Wilbury Way, Hitchin, Hertfordshire.*

ASSEMBLY CABINET

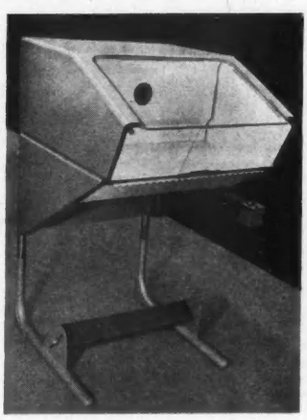
Filtered Air

DUST-FREE assembly can be carried out in a new series of cabinets now available.

The first of the cabinets are being used for the assembly of miniature servo motors. Through them passes a steady stream of filtered air supplied by a 5 in axial-flow blower. The two filters at the back of the cabinet give a removal of dust down to 5 microns.

The assembly area in each cabinet consists of a transparent roof and a transparent door which, when opened, automatically switches on a light and allows the operator to insert his hands, one on each side of a narrow Perspex flap. This device prevents the withdrawal of both hands in order to assemble a component outside the cabinet.

There are no cross pieces in the transparent roof to obstruct the vision, and the height of the assembly area is adjustable to suit individual operators. There is a foot rest at the bottom. The flow of air allows the operator to smoke while working and an ash tray is fitted within



easy reach on the right of the cabinet. The height adjustment is obtained by sliding the whole chamber on the upright members of the tubular frame. The foot rest is also adjustable both for height, by sliding it in the slots, and for angle. *Plannair Limited, Windfield House, Epsom Road, Leatherhead, Surrey.*

TUBE JOINTS

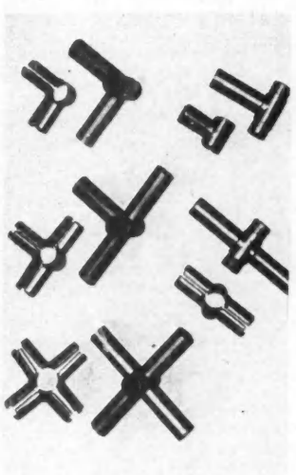
Quick Erection

A NEW range of tube joints requires neither bolts nor welding for erection.

One claim for the "Clinch" joints is that erection is very quick and simple, requiring only a locking wrench or spanner. The five standard forms illustrated allow most types of structure to be built. The final assembly is completely rigid.

The parts of the joints are made by resistance welding and are sold either as joints alone or with tubing which may be cut to required length or supplied random. Joints are available for tubing 1¼ in outside diameter by 16 swg and will be ready shortly for 1 in outside diameter tubes. Other sizes will follow. They are finished either self-coloured and oiled or electrogalvanised. The cost is low—the small T being priced as 1*s* 9*d*.

To assemble the single T, it is first slid over the main tube; the sprung spigot stems are then compressed with the wrench and the side tube slid over them and hammered home, removing the



wrench at the same time. Other joints are formed similarly. *Access Equipment Limited, Maylands Avenue, Hemel Hempstead, Hertfordshire.*

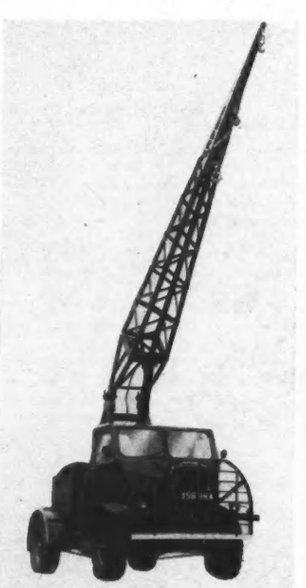
LORRY CRANE

Good Manoeuvrability

ORIGINALLY designed for handling lighting standards the Kwiklift lorry-mounted crane has great manoeuvrability.

Other claims for it are low operating costs, easy maintenance, and low first cost. The Kwiklift is rated for loads up to 2½ tons to heights of 20 ft. Basically it consists of a hydraulically operated crane mounted on a Morris Commercial or Bedford chassis. It is capable of travelling at 30 mph.

The jib is constructed of angle sections and is carried within the main frame on bushed pins. It has three permanently fixed swivel hooks, one of which will lift 1 ton to 21 ft 7 in, the second 2 tons to 19 ft 8 in, and the third 2½ tons to 17 ft 9 in. At the lowest position of the jib the hooks are 5 ft above ground level. The jib is operated by a single hydraulic ram controlled from the cab. A flow control valve governs the lowering speed. *Cohen Brothers (Electrical) Limited, 11 King Edward Buildings, Bury Old Road, Manchester 8.*



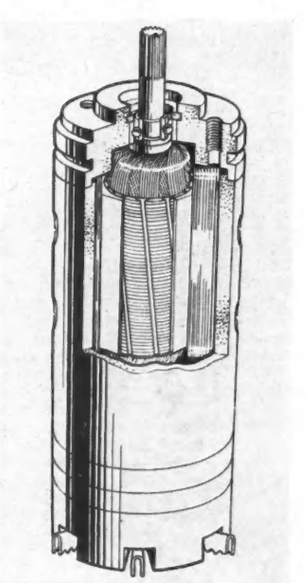
SPLIT FIELD MOTOR

Servo Systems

A RANGE of split field miniature motors for servo systems is now available.

The model illustrated is the size 11 which has an outside diameter of 1·065 in and a length of 2⅞ in including the shaft. The windings provide a torque proportional to the field current and the centre tapped field allows its use for relay servo operations. The same frame size can also be wound for shunt or series characteristics.

When fitted with a pinion, the motor can be used directly with the firm's range of gearheads which cover ratios up to 1,000 to 1. The motor may be mounted either by the circular groove or by the tapped holes in the front face of the housing. The field current is 50-0-50 mA and the resistance per winding 300 ohms. Armature resistance is 27 ohms and current at stall 0·3A. Maximum stall torque is 40 gm-cm. All field connections are brought out to terminals so that the desired characteristics can be obtained. *Vactric (Control Equipment) Limited, Sloane Street, London, SW1.*



HYDRAULIC DRIVES

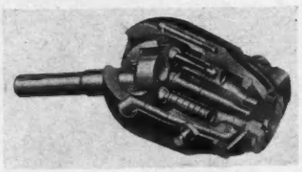
Axial Pistons

AXIAL piston hydraulic units in the Hydro-Titan range are being marketed in this country.

There are 16 units in the series which may be used for pumps or motors depending on the control mechanisms and the mounting. The range of capacities and torque rating as pumps is from 3·9 to 2,800 gallons per minute at standard speeds which range from 3,000 rpm for the smallest size to 140 rpm for the largest. Delivery pressures are up to 5,000 lb per sq. in. As motors the units have a torque range from 9·5 lb-in to 54,700 lb-in, per 100 lb per sq. in operating pressure.

Two main types of standard housing are available. The first allows the unit to be used as a fixed capacity pump or motor and the second allows for variable capacity units. Several control methods are available, ranging from a handwheel to exact electro-hydraulic systems. They can operate in any position.

The working parts of the units are contained in a steel body which can be



moved through an angle relative to the shaft to change the stroke and therefore the output or speed depending on whether the unit is being used as a pump or a motor. Variable speed units are completely reversible.

The seven pistons are connected through ball and socket joints to a driving flange on the main driving shaft. These pistons move in a rotating cylinder barrel, the outer end of which bears against a stationary timing plate in which are two kidney-shaped ports. In variable units the body is mounted on trunnions to allow for change of stroke. The complete unit is mounted in a casing which allows it to operate immersed in oil and also takes the appropriate control system. Pressure relief valves are available for use with the pump units. *Keelavite Hydraulics Limited, Allesley, Warwickshire.*

CONTINUOUS WEIGHER

High Accuracy

CONTINUED high accuracy of output is one of the claims for a new continuous weighfeeder.

The accuracy obtained is plus or minus 1 per cent over any part of the machine's range based on 1 minute readings. Better results can be obtained with particular materials.

The machine has a double gate system, one operating outside the other. The inner gate has a central slot and it is over this that the outer gate operates. For large corrections both gates operate together, but normally only the outer gate operates, exposing more or less of the central slot.

The weigh deck or platform is only 3 in from the hopper outlet gate and is completely covered by the belt which protects it. The weigh bar is sealed by rubber diaphragms and the steelyard mechanism is enclosed in a sealed box. The weight setting knob is outside the box and its spindle passes through a gland to prevent the entry of dust.

To secure a non-slip drive and to

avoid fluctuations due to changes in hopper loading, the main belt is driven by a second belt from the inside. This inner belt is under high tension to avoid slip, and the heavier the load from the hopper the greater the drive pressure between the belts. A fixed internal deck supports both. The delivery range of the machines is from 50 lb to 5 tons per hour; individual machines have a range of 100 to 1. *Baker Perkins Limited, Westwood Works, Peterborough.*

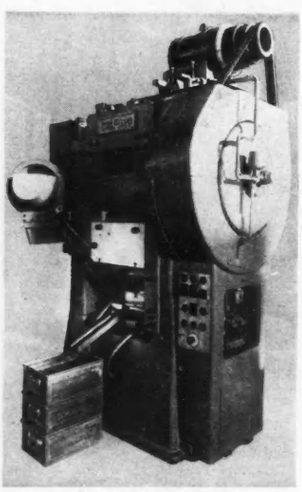
FORGING PRESS

200 ton Capacity

A WORKING load of 200 tons can be exerted at 30° before bottom dead centre by the new Colforg P300 cold forging press.

The machine is designed for forging a large variety of parts. It will take multiple tool units allowing up to six forging operations to be carried out per stroke. The tool design allows quick change of the complete unit to another that has been preset in the toolroom.

The frame is a steel structure fabricated from sections. It is held together by four vertical prestressed tie rods, and is also braced internally against any lateral deflection. The ram slides extend below the working plane to ensure control. A 20 hp motor drives the flywheel through a 3 speed V-belt to provide stroke rates of 60, 75, or 90 per minute. The crank is engaged by a clutch of the pneumatic-setting spring-release type. These controls are electrically interconnected for safety. There is an epicyclic gear between flywheel and crankshaft, which allows quick braking



and compact design. The stroke is 4 in and the ram area 22 in by 27 in. *Camp Bird Limited, Camp Bird House, Dover Street, London, W1.*

AUTOMATIC INDEXING MACHINE

Six Spindle

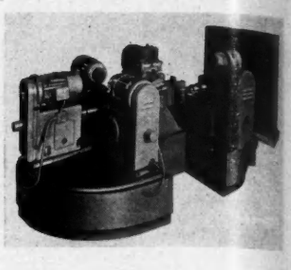
NOW available in this country is a new Wiest indexing machine—model WS-406/U.

This is a six-spindle universal automatic machine designed for producing most components in ferrous and non-ferrous metals. Several operations can be performed simultanecusly at three ends.

The base casting is 18½ in high by 5 ft 5 in wide by 7 ft 6 in long. The indexing drum is of solid construction and is heavily supported on both sides. The four stations are indexed by a Geneva motion with a heavy bolt for accurate positioning.

The control mechanism for the jaws of the work-holding fixtures is not enclosed in the drum—an arrangement making for greater stability. The jaw design is self-centring and allows adjustment after assembly. The complete fixture can also be adjusted on the drum. Clamping pressure is adjustable up to 3,000 lb.

The standard machine is fitted with six unit heads; three for machining and



three for threading. The machining units have a boring capacity up to 1¼ in for mild steel. Power is supplied by a two-speed pole-changing motor with a stepped pulley giving a speed range from 700 to 2,800 rpm. The maximum stroke of the machining unit is 4½ in. The feed is controlled by a lead screw driven by a chain. Feed rates can be adjusted from 0·0005 to 0·018 in per revolution. Length of feed is controlled by two trip dogs. The threading units are lead-screw controlled. Standard models have a maximum stroke of 3½ in. *Embassy Machine and Tool Company Limited, 248 Watford Way, Hendon, Middlesex.*

LEAK DETECTOR

High Sensitivity

THE ABILITY to detect leaks as small as 1×10^{-10} standard centimetres of air per second is claimed for the M60 mass spectrometer detector.

The instrument uses helium as the tracer gas for both vacuum and pressure systems. The sample is drawn through the ionisation chamber of the analyser tube and the positively charged ions are deflected according to mass. The design is such that helium ions are deflected exactly 90° and fall on a collector plate where they generate an electric current. This is amplified and displayed on a meter or can be used to operate an alarm.

A selector switch on the instrument allows the choice of sensitivities lower than the maximum by factors of 3, 10, 50, 150 or 500. An automatic balance system is incorporated to allow faster testing where large leaks may occur, but can be cut out if desired. Operation is possible when the system under test is at a pressure of 40 microns. A panel light gives warning of filament failure.

It is claimed that from a cold start it takes about 20 minutes to pump down to operating pressure. *General Electric, Lynn, Massachusetts, USA.*

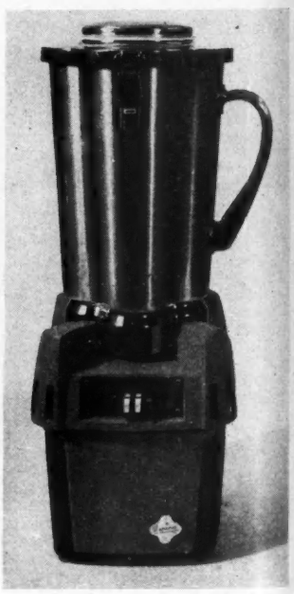
BLENDER

Viscous Ingredients

AN INDUSTRIAL version of the Waring Blendor will find uses in the catering, paint, and plastics trades.

The model CB-4 has a mixing capacity of 1 gallon and an overall height of 23 in. It weighs 36 lb. The stainless steel blades in the container rotate at speeds of 14,000, 17,000 or 19,000 rpm as required, so that the blending operation is accomplished in a short time. It is claimed that the design ensures chemical cleanliness.

The control switch has three settings of low, medium and high for the three operating speeds, and an off position. The base is a zinc diecasting with a crackle two-tone finish. The container is made of stainless steel with stainless steel blades; it has a handle and clamp-on splash cover with sealing gasket. In the centre of the splash cover is a covered opening for taking samples and for adding ingredients. The motor is rated for 250V 15A at 50 cycles. *Winston Electronics Limited, Shepperton, Middlesex.*



Closing the Manipulator Gap

UNTIL recently there was a serious gap between the light and heavy duty manipulator. Now, several firms have noticed the omission and three have strengthened their original master-slave manipulators in an attempt to meet the need. Two other machines have been introduced by one company: a scaled-down version of their larger electrically operated mechanical arm; and the other a totally new model designed to guard against irradiation effects from the keen penetration of alpha dust and gamma radiation.

Infinitely Variable Lateral Displacement

Since the development of the Model 8 Master Slave Manipulator by the Argonne National Laboratory, design improvements have been made by the American Machine and Foundry Company Limited and Pye Limited of Cambridge. Pye now make it in this country by agreement with AMF Limited. A lateral displacement motion which is infinitely variable has been introduced, and permits remote control side-canting of the slave arm with respect to the master arm, 30° either side of the vertical datum. This motion is fully balanced and ensures that, when unloaded, the master arm will remain in the vertical position irrespective of the position of the slave arm. The lateral displacement and the forward lift are powered by direct-current actuators incorporating a brake mechanism. If desired, pedal controls may be used for the two movements, so reducing the fatigue of the operator and allowing him to have his hands on the manipulator at all times.

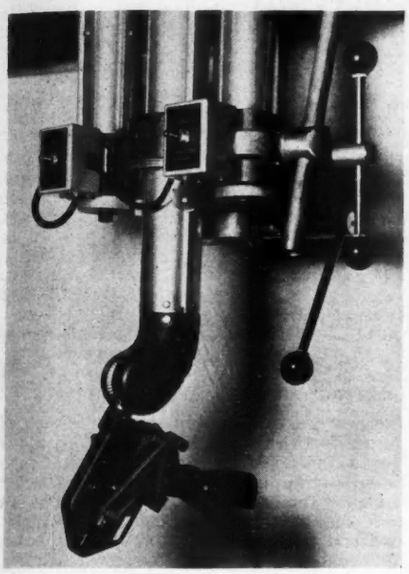


Fig. 1 Pye heavy-duty ambidextrous thumb lever handle and actuator control. The latter may be controlled by pedal.

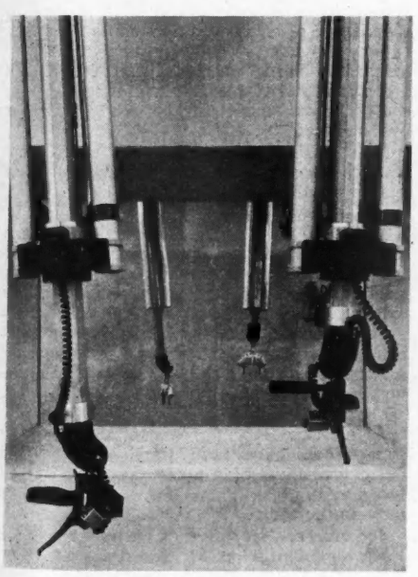


Fig. 2 NE9 Master Stone manipulator designed by Nuclear Equipment for manipulating loads between 8 and 30 lb. Note the pistol hand grip and actuator control positions.

Heavy Duty Manipulator with Bagging System

The new heavy-duty manipulator is capable of manipulating loads of up to 30 lb or 60 lb for a direct grip. Thumb lever control provides an increased mechanical advantage. The operating control is shown in Fig. 1. A complete gas seal is provided by a bag extending from the slave tongs to the cave end of the manipulator access hole in the cell wall. The wall end of the bag terminates in a circular rubber ring with convolutions on the outside diameter. When fitted into the liner tube it is clamped between two rings, thus increasing the diameter and making the seal inside the liner tube. At the tong end the bag divides into two fingers sealed to a pair of sub-jaws between the tong finger and the tong body. The sub-jaws have been developed to allow a contaminated bag to remain inside the active area when withdrawing the manipulator for maintenance. The new sealing system eliminates the conventional wall plate supports for the manipulator through tube; instead, a solid metal sleeve is located between the 10 in diameter wall liner and the 8 in diameter manipulator through tube.

Pye stereoscopic television may also be profitably used for viewing inside the caves.

Complete Range Covered

The recent addition of three new items to their existing range of manipulating equipment makes Nuclear Equipment Limited of Watford the first company to offer a complete range of remote handling machinery which will cater for loads up to 5,000 lb. The company is owned jointly by Savage and Parsons Limited of Watford and General Mill Incorporated of the United States. The established NE8 model was originally designed and developed by General Mills Incorporated; but there was a severe limitation to the maximum weight that it was permitted to carry. As a result, Nuclear Equipment have built a model NE9 (see Fig. 2) which is fundamentally the same as the NE8 but stronger, manipulating loads in the 8 to 30 lb range or on a straig htlift 96 lb using a grip; whereas the previous straight lift on the NE8 was limited to 7 lb with a grip. In addition a new jaw has been designed employing a roller chain; a pistol grip replaces the old type of hand grip, and is less fatiguing on the operator; and the actuation switches are placed so that they may be operated without the hand leaving the grip.

Mechanical Arm with Master Rotary Selector

There have been three models of the General Mills Mechanical Arm—the model 300 of 750 lb capacity, the 2,000 lb model 500, and 5,000 lb model 700 (the figures given are for straight lifts). But to bridge the gap in capacity and price between the master slave manipulator and the model 300 mechanical arm, the model 100 has been introduced with a manipulating capacity of 40 lb and a direct lift of 200 lb (Figs. 3 and 4). The control panel has seven toggle switches providing two-speed control for each motion in either direction. There is also a master rotary selector switch a speed range change, giving a total of four speeds. The power is supplied by 115 V single-phase motors, and all switching is accomplished by means of alternating-current voltages. Three motions are provided in the arm: grip, wrist rotation and elbow pivot; the latter has a sweep of 180° and an arc of 270° in the vertical plane of the telescopic tubes. Brakes or irreversible drives are used in each motion to eliminate creeping under load. The whole arm is carried on an overhead crane which allows the complete area to be spanned.

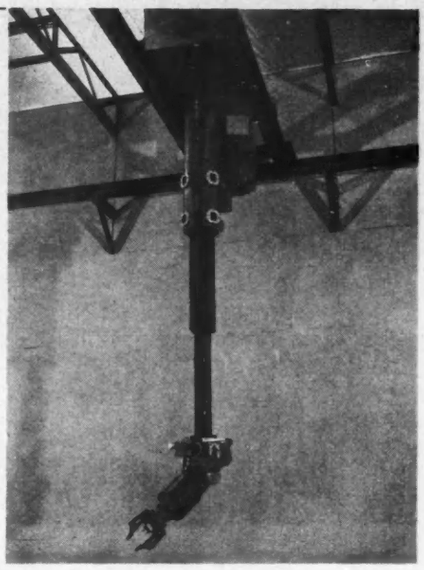


Fig. 3 General Mills's powered mechanical arm, model 100, made in this country by Nuclear Equipment. It has a manipulating capacity of 40 lb, and with overhead crane movement allows maximum freedom of access.

Fig. 4 Controlling the General Mills model 100.

Alpha-Gamma Resistant

General Mills model 150 Mechanical Arm is totally new to their range and is designed specifically for alpha-gamma handling, having all the parts encased and sealed. Control is from a portable box with on-off buttons for each motion, and individual lever action switches provide direction and infinitely variable speed controls.

The arm is powered entirely by direct-current or permanent-magnet field motors for nearly constant torque output. There are six motions: grip, wrist, elbow, and shoulder bending; and the rotation of the wrist and shoulder.

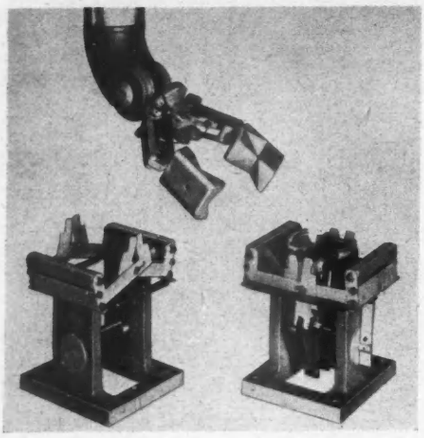


Fig. 5 Special purpose tongs that may be remotely interchanged.

Power Manipulator with Joy Stick Control

The General Electric Company make an electric powered manipulator which is capable of handling a 750 lb load using a hook with all the arm components vertical. The grip force of the hand fixture is limted to 175 lb and the jaws will open up to 5 in. The wrist, which may be rotated continuously with a torque of 40 lb-ft, is supported by a forearm, upper arm and shoulder —the arm joints may rotate through 180° about the pivot, and the shoulder may rotate continuously about a vertical axis. The shoulder is mounted at the base of a set of vertical telescopic tubes with the upper section rigidly fixed to the overhead crane, and the complete apparatus may be traversed across the total working area. The various motions of the manipulator are driven by a variable-frequency three-phase squirrel-cage induction motor. This type was chosen for the freedom from brush gear and its compact size, and also the fact that no insulating materials are required in the small rotors. A speed range of 8 to 1 is available for each motion. The manipulator is controlled by two joy-sticks which cater for all the motions of the manipulator. Since there are no mechanical linkages between the manipulator and the console there is no distance limitation between the manipulator and the operator, and television screens may be used if the distance is either too great or the position awkward.

Another Attempt to Close the Gap

The Central Research Laboratories, Inc. of Minnesota designed and developed a master-slave manipulator called the model 7 has been made in this country by H. M. Hobson Limited. the latter are prepared to manufacture any of the CRL range which now exists. However the model 7, which is the only one of the range so far produced by H. M. Hobson Limited, is a lightweight mechanically operated manipulator with a handing capacity of 10 lb per arm and a weight of 58 lb. It may safely manipulate a weight of 4 lb. A flexible plastic booting may be placed over the metal parts to prevent the slave arm becoming badly contaminated by radioactive materials. The span and reach dimensions may be altered to requirements. In collaboration with the UKAEA the model 7A has been developed by H. M. Hobson Limited, and with the use of lead shielding adequate protection against α, β and γ radiation is now possible.

Hydraulic Operation

A heavy duty manipulator has been designed and developed by A. C. Wilson and Partners Limited and built by Palatine Tool and Engineering (Surbiton) Limited. It has a telescopic arm which may be rotated; any elbow motion is supplied by the use of specially designed heads. There are two power take-off drives to operate the instruments and tools. The manipulator is hydraulically powered using two pumps with remote manual control. It will lift a load of 1 ton through a height of $6\frac{1}{2}$ ft and will exert a downward thrust of $1\frac{1}{2}$ tons and a sideways force of $\frac{3}{8}$ ton.

Notes and News

University Reactors

In a written answer to a question in the House of Commons before the Christmas recess the Parliamentary Secretary representing the Minister of Science stated that the University of Birmingham, the Imperial College of Science and Technology and Queen Mary College, London, the Universities of Manchester and Liverpool jointly, the University of Southampton, and the Scottish Universities jointly with the Royal College of Science and Technology, Glasgow, had applied for financial grants to cover the complete cost of building a low-power research reactor. It was also stated in the House that the Universities of Birmingham, Durham, London, Manchester and Southampton already offered facilities for the training of nuclear engineers and reactor physicists. From 1956 to 1960 an annual average of 90 students took post-graduate courses and about 100 students chose nuclear engineering or reactor physics as an option in their final undergraduate year.

Coordination between Iron Curtain Countries

Leading scientists from twelve Iron Curtain countries have recently concluded a series of talks at the Joint Nuclear Research Institute near Dubna, Russia. A plan has been devised to allow countries other than the Soviet Union to view the large number of pictures (reported to be more than 12,000) of the charged particles fired by the proton-synchrotron into a new bubble chamber at Dubna in order to discover any clue that may have been missed about some new fundamental property. It was also reported that the intensity of the beam of the proton-synchrotron at Dubna had been intensified by a factor of ten. This increase in the power has led to the discovery of antisigma-minus hyperon and it is expected that further discoveries will be made. A proposal was also put forward at the talks to sponsor additional conferences for those countries behind the Iron Curtain on problems of interest to nuclear scientists.

Fairey Activities

Fairey Engineering Limited have got a sizeable foot in the door leading into the nuclear engineering field. In the early days most of their research work consisted of contracts for Atomic Power Construction Limited, but now the latter has a research branch of its own at the Heston factory of Fairey Engineering. In spite of APC setting up a section of their own, Fairey Engineering continue to assist in the research work still necessary for the Trawsfynydd station (being built by Atomic Power Construction Limited) and also have commitments towards the Authority—notably the design and construction of HECTOR (Heated Experimental Carbon Thermal Oscillator Reactor) at Winfrth (Atomic Review 16 Sept. '60), which is expected to go critical in 1962. In order to develop methods for the accurate control of the temperature required in HECTOR it has been necessary to build a temperature stability rig at Heston to simulate the core of HECTOR (see Fig. 6). Fairey Engineering also make considerable use of the radiation facilities at Harwell for in-pile or loop tests.

Axial Flow Compressors

A comprehensive bibliography on axial-flow compressors has been issued by the UKAEA. Literature on blades, cascades and other related material is listed for the period 1934 to 1958. The bibliography has been prepared by staff at the Research and Development Branch, Capenhurst, and is published by HMSO at 7*s*. Each section under the above three headings gives the relevant material published in books, articles that have appeared in journals, and reports. In some cases information on patents is included.

(" Bibiography on Axial Flow Compressors, including Blades, Cascades and Other Related Material (1934-1958): Part 1. By R. Bramley and E. McCoy. DEG Information Series 80 (CA).)

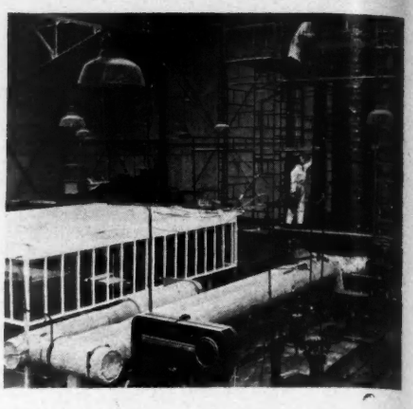


Fig. 6 Temperature stability test rig during erection at Fairey Engineering's works at Heston.

Underwater Nuclear Equipment

A new method for the machining of irradiated nuclear fuel elements has been commissioned at the Lucas Heights Australian Atomic Energy Commission Research Establishment, near Sydney. The equipment has been installed in a 16 ft deep cropping pond lined with stainless steel and will operate beneath 9,000 gallons of demineralised water. The spent fuel elements will be packed into new containers and sent to the United Kingdom for reprocessing.

Reactor Notes

Another German Station by 1965: A 150 MW(e) organically moderated reactor is to be built by a syndicate of south-west German power companies who have recently awarded a £600,000 contract to North American Aviation, Inc. The project study is expected to be completed by the end of the year and the reactor producing power by the end of 1965.

New USSR Research Centre: An atomic research centre is to be established in Latvia and will be based on the reactor now being built at Salaspils, near Riga.

Fuel for Finland: The Trilateral agreements have been signed for the transfer of approximately 13 kg of uranium with 20 per cent enrichment and 5 gm with 90 per cent enrichment for the Triga Mark II reactor that is being exported by the General Dynamics Corporation of the United States to Finland. Under a further agreement with the IAEA the United States will supply the fuel free. (Atomic Review, 18 Nov., '60.)

Dutch Core for Dragon: Neratoom of the Netherlands have been given an order for the construction of the core structure for the Dragon Project. Three firms will assist in meeting the order.

Progress in Philippines: Construction of the 1 MW pool reactor for the Philippines has begun. It is expected to reach criticality by December of this year.

University News: A 10 kW pool-type reactor using highly enriched uranium has been designed and constructed for Ohio State University by Lockheed Aircraft Corporation.

Companies

Qualified Optimism in Steel

United Steel Chief on the Future Outlook

RIGHTLY observing that it is tomorrow we want to know about, yesterday is interesting but no more than that, Sir Walter Benton Jones, the UNITED STEEL COMPANIES chairman, poses three questions in his annual statement.

World steel production has doubled from 152 million tons a year twenty years ago to the present 340 million tons. British production in the same time has also doubled, from 12 million to 24 million tons. Will expansion continue? Sir Walter believes that there is nothing phenomenal about changes in the kind and degree of demand. It would be phenomenal if there were no change.

There is no doubt about the intentions of the British iron and steel industry to lift its production over the next few years. What waits to be seen is how far the demand matches the increased capacity.

The second question was the much argued—Will steel continue to play so large a part? On this the United Steel chairman holds the opinion that competition from other materials may increase but there is room for all and expansion by the "new boys" will itself call for many of the products of the steel manufacturers.

New Competitors

And thirdly: Will new countries become steelmaking themselves and take the bread out of the mouths of the established steel producers? Part of the answer to this is the long time needed and the high cost of building steel works large enough and suitably equipped to convert iron ore into steel products. It also costs much more to build new than to modernise existing works. Small works making convenient products from scrap can be expected to be put up in a number of countries. Such competition has limits but cannot be ignored.

For itself United Steel with production of steel, pig iron, coke and iron ore all at record levels, is planning to raise its ingot steel output to 4 million tons a year in 1965.

The company has not gone directly into one of the most important of developments in recent years, the installation of continuous wide strip mills. Instead it has acquired a little over one and a half million of the Ordinary shares of JOHN SUMMERS AND SONS, one of the pioneers in wide strip.

United Steels' excess income over expenditure last year was 30 per cent higher than in the year before. This has to be related to the rate of working. In 1959 this was between 69 and 94 per cent of capacity, giving an estimated average for the year of 83 per cent. Through the last financial year the company's four steelworks and the associated engineering works, with one or two departments excepted, were working to capacity. Thus a fully productive year is being compared with one when the plant was on short time.

The consolidated surplus after taxation last year was £12,849,000 (£10,544,000 in previous year). After transfer to fixed assets and other reserves the amount carried to the appropriation account was £7,780,000 (£7,259,000).

Reduced Earnings in Heavy Engineering

Falling demand for castings and forgings for the shipyards, heavy engineering and the electrical engineering industry has affected the output of WILLIAM BEARDMORE and Company to the point where Sir John Green, chairman of THOS. FIRTH AND JOHN BROWN Limited, has to report in his annual review that no dividend was paid by the subsidiary to the parent company.

Group profits overall, despite the difficulties in heavy forgings, were up by £286,382 on the previous year, to £5,353,925. The companies who put this brighter face on things were FIRTH-DERIHON STAMPINGS, FIRTH-VICKERS STAINLESS STEELS, and the parent company itself.

For the parent company, output of rolled products, hardened steel rolls and stainless forgings increased and the additional profit rather more than compensated for the much lower earnings on heavy forgings and general engineering products, where both demand and profit margins were down.

Firth-Vickers Stainless Steels celebrated its jubilee year with record output and improved results. The consolidated before-tax trading profit more than doubled—from £1,175,228 to £2,537,685. The dividend taken into the Firth Brown accounts increased from £225,000 to £375,000.

Firth-Derihon also substantially increased turnover and profits. The company supplied a significant number of stampings in special steels produced by vacuum melting. Firth-Derihon are among the companies closely watching the events in the motor business. During the past financial year they were able to overcome a smaller demand from the aircraft industry by increased deliveries to the vehicle manufacturers.

Machine Tool Spending

Group outlay during the year on machinery, land, buildings and plant was £1,352,160. Just over a million of this was spent by the parent company on new machine tools, the completion of a new heat treatment department for heavy forgings and part construction of new shops and installation of a new 4,000 ton press.

Capital expenditure at William Beardmore was principally directed to the completion of a new heat treatment plant, the demolition of the open hearth melting plant and part installation of increased facilities for hardened steel roll production.

Surveying the general position, Sir John Green says that until the world demand for new ships and heavy capital equipment revives, the heavy side of the group's activities will remain unprofitable.

Requirements for all types of stainless steel are staying high and the prospects are that the group's stainless steel capacity will remain fully occupied.

In a particularly precise look at the future, Sir John Green lists coal gas and electricity as two services whose cost have been substantially increased; in addition there is a wage increase to be met. At the same time selling prices have been reduced for most of the main products. It is calculated that in the absence of any improvement in manufacturing efficiency, the profit margin of the group will be reduced by at least £500,000.

The Rate Burden on Every Ton of Steel

According to one calculation the direct rate burden carried by the steel industry is as high as 8*s* on every ton of finished steel. As short a time ago as 1955/56 the figure was 1*s* 4*d* a ton.

With the proposed total elimination of industrial de-rating by 1963 it is estimated that the cost of local rates in each ton of finished steel may by then rise as high as approaching 16*s*.

Sir Ellis Hunter (*inset*), chairman of DORMAN LONG AND COMPANY, gives these serious figures in his annual company report and lists some of the adverse movements taking place despite the satisfactory conditions of demand.

Last February's price reduction in rolled steel products was followed in

September by increased coal and coke prices and in November wages rose. Production costs felt the effect of these changes immediately. The indirect increases in transport and other costs springing from the rise in coal prices have yet to make themselves felt.

Among other, less publicised, cost increases the outstanding one is the local rate burden. The coke ovens, blast-furnaces and much of the extensive process plant of the steel industry is rateable, not merely its industrial buildings. Local rates are also obtained from mines and quarries providing raw materials—all this adds up to a substantial addition to the steel industry's final costs. Put in another way it directly lowers the competitiveness of the final products in the export market.

The trading results of Dorman Long for last year make happier reading. From group profits (before tax) of £5,920,000 in the previous year, the profits last year rose to £8,237,000. In each case the total is after allowing for profits from subsidiaries allowable to outside shareholders and also putting £1,000,000 in each year to the fixed assets replacement reserve of DORMAN LONG (STEEL) Limited.

There was an interesting change in the proportions in which the profits came from bridge building, engineering and chemicals and from iron and steel. In 1959, 45 per cent of the profits came from bridge building, engineering and chemicals. The other 55 per cent came from iron and steel. In 1960 the proportions had changed to 24 from bridge building and so on and 76 per cent from iron and steel.

Sir Ellis Hunter explains that reduced demand and lower margins on contracts completed during the year accounted for the lower bridge building and engineering results. An improvement in output began in the later months of the financial year. Meeting full demand for rolled steel products the group stepped up output at all works and new installations contributed increasingly.

For Dorman Long (Steel) Limited structural steel, plates, rods and wires have been good markets. Universal beams and columns continue to attract interest. A temporary surplus in the steel industry's sheared plate consumption is feared but the long term consumption is expected to grow. The company's plate mills are expected to be fully occupied for some time with orders already in hand.

Dorman Long will be putting plastic coated sheets for cladding industrial buildings on the market shortly.

Although Sir Ellis Hunter is not prepared to call the 1961 outlook—"set fair"—he does not think there is justification for a pessimistic approach. The steel order books are satisfactory but consumers have rebuilt their stocks so that a decline in the level of industrial activity would quickly be reflected in the mills.

Faster Depreciation Urged by South Durham

Some vigorous proposals for reform in the conditions imposed on steel industry are put forward by Mr. B. Chetwynd Talbot, chairman of SOUTH DURHAM STEEL AND IRON Company. South Durham's gross trading profit has increased from £7,847,094 to £8,066,717, but after depreciation, pensions, interest charges and directors' fees, the net profit is £4,482,706 compared with £5,292,885 in 1958/59.

A heavy part of the charges met by the company are interest on capital investment on plant not yet producing earnings. Interest paid to FCI and to BARCLAYS BANK during the year was £1,025,481. Mr. Chetwynd Talbot urges that the element allowed for the rate of return included for interest on money by the IRON AND STEEL BOARD in their price structure for steel is inadequate. The South Durham directors believe that the Iron and Steel Board should have given a more liberal allowance for depreciation on plant and machinery. They would like to see the period adopted for the life of plant and machinery brought down from 25 to 20 years.

Steel production at the Cargo Fleet works of the company was brought back to normal during the year and the full production enabled the benefit to be obtained from the capital expenditure made under the company's stage two development.

Various large orders for sectional materials and steel rails were booked, including one for 26,000 tons of Larssen steel piling for the Suez Canal Authority.

The Wolf Safetymaster Electric Tool

Domestic power tools are the logical outcome of a do-it-yourself philosophy. The firm who foresaw their potential are now producing tools with a high degree of refinement.

THE SAFETYMASTER brings engineering right into the home, using the term engineering in its widest sense. It is so designed that it can be used by anyone with the merest technical know-how. As its name implies, the Safetymaster is far more than a simple industrial electric drill scaled down for the home workshop. Its design incorporates the ultimate in safety for the operator, commensurate with portability, and at an acceptable price.

The handyman in the modern sense is a comparatively recent addition to the human species. He is a product of post-war Britain, a man who can ill afford the high labour costs of today to do simple repair jobs around the house, or on his car. In some other countries, with different economic conditions he is less evident.

The handyman may acquire a high degree of technical skill, equal perhaps to that possessed by those painstaking beings whose products we admire at model-makers' exhibitions. Or he may never become really skilled, and yet would still call himself a handyman. The Safetymaster is designed to satisfy either class. Not only does it enable him to perform odd jobs at less expense of spare time, but it also encourages him to tackle more and bigger tasks.

The Safetymaster is produced by Wolf Electric Tools Limited, of Ealing, London, W5. Although the basic domestic power tool was originally conceived by Wolf long before the Second World War, its appeal would probably have been very limited if it had been introduced then. When the war finished, however, Wolf saw that conditions were very different. Like all other firms who had been kept over-busy with military requirements—in this case industrial power tools—they now faced the possibility of a big slackening-off. But being quick to recognise the handyman as a permanent newcomer to society, they decided to provide him with a portable power tool tailored to his needs in both design and price.

The result was the Cub ¼ in drill, introduced at the end of 1949; but in point of fact it was far more than just a drill. Shortly before the Cub was due to appear on the market Wolf had a sudden flash of inspiration. Why not offer some items of solid bench equipment by way of attachments, instead of just the wire brush, etc., usually provided with industrial drills? Accordingly the Cub was offered from the start with a range of optional accessories so that the basic hand drill could be quickly turned into a drill press, a wood-turning lathe or a sawbench.

THE CUB

Thus was the concept of versatility by means of readily interchangeable attachments born. The handyman who had never had a power tool of his own before suddenly found himself with not one but several. The basic price of the Cub without attachments was £4 19*s* 6*d*, and it weighed a mere 3 lb.

It is worth noting that Black and Decker in America were working along broadly similar lines to Wolf in the immediate postwar years. Their first domestic power tool, the ¼ in "Handy Utility," appeared on the market about the same time as the Cub, but it was somewhat larger and lacked the advantage of interchangeability of its accessories. More recently the American conception of a domestic power tool has rather veered away from our own, since the handyman over there generally prefers a special tool for each job, rather than a ubiquitous tool with accessory variation.

The success of the Cub and its accessories was immediate. Demand outstripped production by nearly two and a half times over the first year or so, until manufacture was stepped up. Thus did Wolf reap the reward of being quick off the mark in recognising the potential of such a tool. But they also paid a certain penalty. Once a new basic idea had been launched there was nothing to stop others from following suit, despite patent protection of the details. Other firms were quick to produce similar tools incorporating improvements over the Cub that could be made easily enough after some operating experience. Introduction of the Cub, therefore, was only the first step in the production of a quality domestic tool at an acceptable price. Continuous development of both the basic drill and further accessories was needed if Wolf were to keep a lead over their competitors; they could not afford to rest on their laurels with the Cub. The Safetymaster is the direct result of a "keep one step ahead" policy.

Fig. 1 One of the original Cub drills.

Fig. 2 The Safetymaster.

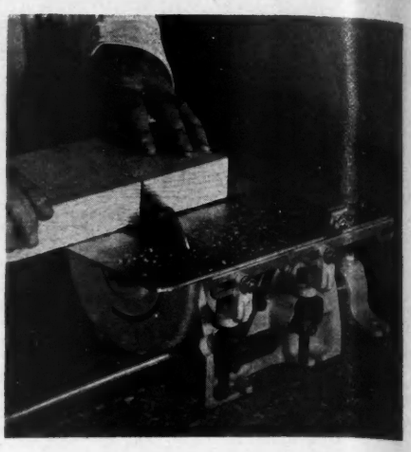


Fig. 3 (above) Bench saw set.

Fig. 4 (below) Orbital "Supasander" attachment.

As soon as the Cub's popularity had been assured, and production was keeping pace with demand, Wolf started to add further accessories; since they realised that here lay one of the main keys to success. Unfortunately not all the later accessories achieved the same degree of acceptance, the biggest contributory factor being the limited power of the Cub motor.

Rival firms were quick to realise this, and other more powerful tools started to appear on the market, some even using a similar system of attachments. Wolf had to act fast, and so they introduced the ¼ in Quartermaster. To keep development time as short as possible the new tool was derived from one of their industrial range, with modifications to suit the domestic market.

At the same time it was realised that the Quartermaster was not the real answer. In order to re-establish their lead in the domestic tool field Wolf had to develop a completely new design. With a greater degree of refinement accompanying the necessary increase in speed and power, and with a wider range of stronger accessories than the Cub, the success of the newcomer, the Safetymaster, was assured before it ever left the drawing board.

THE SAFETYMASTER

The Safetymaster was introduced in 1958, at a price of £9 17*s* 6*d*. Its power input went up from the 210 W of the Cub to 325 W, with a weight increase of only 13 oz. The spindle speed was increased to 2,400 rpm on full load, a compromise between the drilling speed of 1,330 rpm, as used in the Cub, and the much

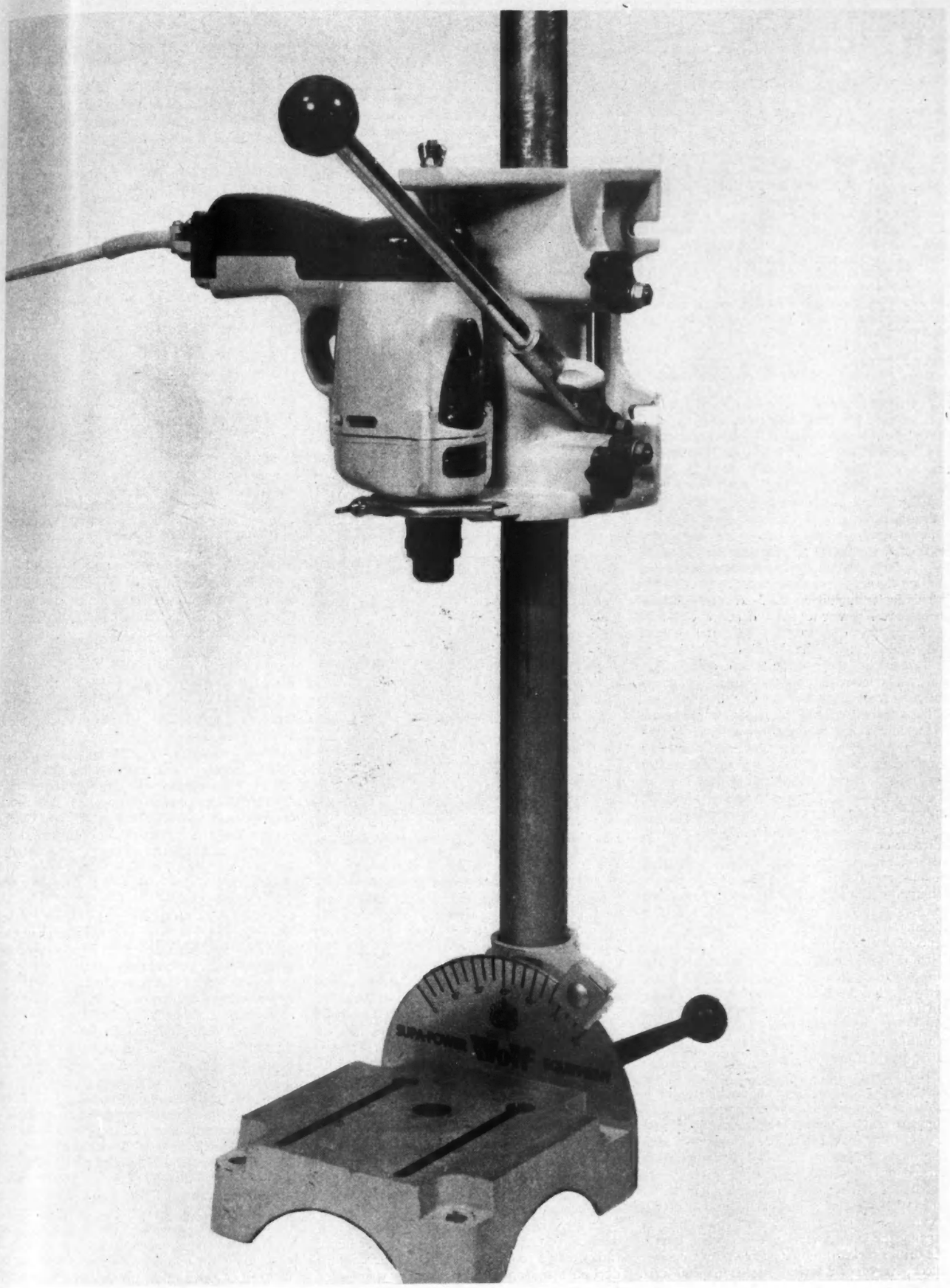


Fig. 5 An original idea must be followed by continuous development to beat competition.

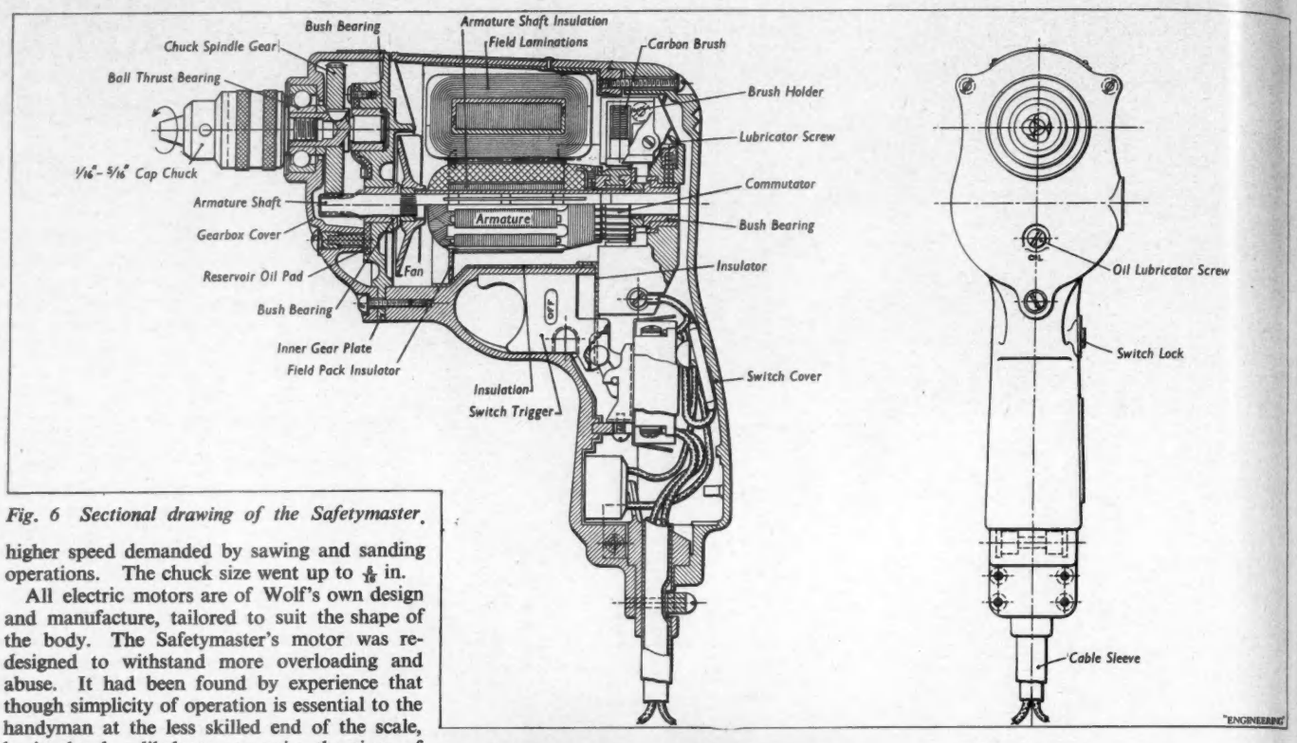


Fig. 6 Sectional drawing of the Safetymaster.

higher speed demanded by sawing and sanding operations. The chuck size went up to $\frac{5}{16}$ in.

All electric motors are of Wolf's own design and manufacture, tailored to suit the shape of the body. The Safetymaster's motor was redesigned to withstand more overloading and abuse. It had been found by experience that though simplicity of operation is essential to the handyman at the less skilled end of the scale, he is also less likely to recognise the signs of overloading, and might unwittingly persist in abusing the tool over prolonged periods.

This factor highlights the fundamental difference between power tools for domestic or home workshop as opposed to industrial usage, and explains why the Wolf organisation is divided so that the two are treated quite separately. The industrial tool will be running intermittently for eight hours per day, but for most of this time it is probably doing work well below its maximum capacity. Furthermore, the operator's experience will render prolonged misuse or overloading unlikely. Being a generally heavier tool, an inherent robustness can be built into the design that will ensure reasonably long life without excessive first cost or repair bills.

A domestic tool operates under entirely different conditions. Firstly, the limitations of a normal mains supply and a severe restriction in bulk mean that there is an inherent power ceiling. Also it is likely to attain or even exceed its rated capacity for most of the time it is running. Furthermore, its saleability is more dependent upon price alone.

These restrictions may be considered partly offset by the relatively small amount of usage per week that the average domestic tool receives. On the other hand it must reasonably be expected to last for a good portion of a lifetime without requiring much attention, however frequently or infrequently it may be used.

The fundamental new design feature in the Safetymaster is the provision of double insulation which renders an earth wire unnecessary. All compartments containing electrical items have a $\frac{1}{16}$ in thick moulded internal lining of a glass reinforced polyester resin. The armature is carried on an insulated sleeve, to preclude the possibility of electricity passing through to the chuck. A special nylon clamp and dielectric secure the cable, so that there is no danger of tugging the cable away from the switch even if the drill is picked up by its cable. As a positive check, every model is works tested to 4,000 volts.

Thus a much higher standard of safety has been set than hitherto, and hazards such as the operator wiring up incorrectly or inadvertently cutting the cable are no longer serious.

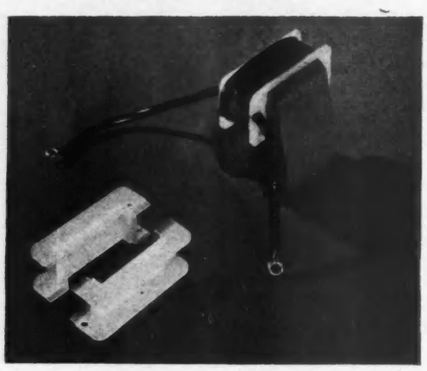


Fig. 7 Horseshoe field pack and nylon bobbin for field windings.

Lighter castings are used in the Safetymaster than in comparable industrial tools, on the assumption that whatever abuse the domestic tool might suffer due to overloading, at least it is extremely unlikely to be dropped on the floor or clamped in a heavy vice. Pressure die-cast aluminium is used where practicable.

In all their domestic tools Wolf employ a simplified internal design to economise in assembly costs. In the Safetymaster the use of a ball bearing is confined to the main thrust bearing behind the chuck, the other bearings being plain with sintered bronze brushes. For compactness the field lamination pack is a horseshoe shape dictated by the style of the body. The Safetymaster also makes extensive use of plastic mouldings, for example, in the switch handle cover, cooling fan and field winding bobbin. The switch is of the trigger type with a push button lock.

Though the Safetymaster was a lineal descendant of the Cub, it was intended as an addition rather than a replacement. Soon after its introduction some of the new features were incorporated in the $\frac{1}{4}$ in "Cubmaster" selling at £6 19*s* 6*d*, and the Cub was then discontinued.

Now Wolf have two modern tools with accessories on the market and can face the future with some confidence. To paint a picture of the Safetymaster's success would be difficult without reference to the sales trends of the Wolf domestics generally since the introduction of the Cub.

TRENDS

Up to 1956 total sales showed a sharp and continuous upward trend, but over the next two years there was a fall. This is partly explained by the Suez crisis and the tightening up of hire purchase restrictions in Britain, but it also reflects the growing number of the Cub's rivals.

The Safetymaster and the Cubmaster have reversed this trend, and during 1960 sales figures climbed back past the 1956 peak. The Safetymaster itself has more than doubled its sales in two years, and the two domestic tools together account for about 40 per cent of the Wolf organisation, which is still being expanded.

It may be wondered whether there are any signs yet of saturation in the home market. Wolf assured ENGINEERING that this stage has definitely not been reached. An independent estimate of the percentage of British households possessing electric tools has been given as 6 to 8 per cent. Furthermore electric tools are not subject to purchase tax.

Sales of Wolf domestics are world wide and in Canada, Australia and India subsidiary manufacturing companies have been established.

Domestic power tools design has, however, always been centred around British and Continental requirements. The Safetymaster conforms with BS memorandum no. 2754, and has been approved both by the Council of Industrial Design and the British Safety Council.

Wolf have already learnt that accessory development alone is not enough to keep them one step ahead in domestic tools, and competition is becoming keener all the time. They have two obvious courses open to them; either to start developing the more specialised tools popular in America; or to develop a still more powerful tool based on the Safetymaster. One thing is certain—whichever one they adopt will be kept a closely guarded secret.

Training India's Electrical Technicians

The Bhopal Training School, now helping to educate 3,000 Indian technicians, owes much of its character and standards to cooperation between the British electrical engineering industry and the Indian authorities.

In 1955 the Indian Government signed an agreement with Associated Electrical Industries appointing them as their consultants in India for the design and establishment of a heavy electrical equipment factory. The project report provided for the opening of the training school in July, 1958, in order to have the required number of artisans and other staff ready for work by July, 1960, the target date for the starting of production. Early in 1958, however, the management was confronted with an issue which threatened to upset this schedule—the non-availability of the training school buildings and the workshop which were being constructed by the Central Public Works Department and were not expected to be completed before the end of that year. The first hurdle to overcome was how to make up for the six months' delay in the opening of the training school as in the ordinary course the first batch of successful trainees would not have been available for commencing production in mid-1960.

The initial training scheme provided for recruitment and two years' training of young men who had completed the 18 months' course in the Industrial Training Institutes (ITI) set up by the Central Government throughout the country. As an emergency measure the management decided, in agreement with the consultants, to reduce the period of training for the first batch of candidates by paying special attention to the quality of the recruits and trying to get as many of those as possible who had acquired in-plant training of at least six months in addition to the eighteen months' basic training in Industrial Training Institutes. The absence of the training school building was got over by putting up half a dozen metpa sheds, each 30 ft by 100 ft. These were originally used as classrooms and subsequently came in handy for a variety of miscellaneous purposes.

UK TRAINING

The installation of machine tools was organised on an emergency basis and over 250 tools were erected and commissioned in a record period of slightly under two months. The training school was actually opened with over 500 trainees on the last day of 1958.

The Bhopal training school now imparts instruction to 3,000 technicians including 120 graduate apprentices. It is proposed to step up this total to 4,000 technicians. Nearly 200 qualified engineers with previous experience have been sent for training in UK at AEI's workshops. Of this 97 have returned after completing their training. More are still to be sent in the next year or two to meet requirements during the later phases of development of the factory. Apart from the senior engineers, who have had a thorough training in Britain, recruitment into the Heavy Electrical Project Engineering offices is normally from its own training school, and the graduate apprentices and draughtsmen trainees who have completed their courses have had an excellent basic training. Potentially all of them are first class engineers and draughtsmen. It only remains to give them the fullest opportunity of developing further their abilities by specialisation in the most appropriate field, and of assuming responsibilities in due course.

The success of engineering industries requiring high degrees of skill and precision depends among other things on the training of adequate technical staff and adept hands correctly phased with the needs at different stages of development of a project. The Heavy Electricals Project (HEP) considered in the first place the maximum possible utilisation of the existing institutions and establishments in the country. It came to the conclusion that the effective solution to the problem lay in the setting up of an apprentice training school as an integral part of the project so that the apprentice engineers, supervisors, technicians and artisans could be given specialised courses of the critical study and practical training as necessary for the electrical industry.

In addition it was deemed necessary to arrange for the training of key personnel in the works of the consultants in design, manufacture and production methods for all types of products. With a view to examining the existing facilities in India the consultants visited the engineering colleges, training institutes, government training centres for supervisors, instructors and artisans, as well as some of the factories and workshops all over the country. An integrated plan of training was then drawn up, and the recruitment of personnel at all levels keyed up with the phased manufacturing programme of the factory.

The bulk of the personnel requirement had to be met by training in India. Hence the scheme for the establishment of a large and modern technical school building with up-to-date facilities, electrical and mechanical laboratories, library, students' assembly hall of 1,000 seating capacity, etc, was implemented without waiting for further progress and decision on the main project.

MINIMUM SUPERVISION

The Training Workshop associated with the school has been planned on the principle of a training-cum-production workshop, and is, in fact, a medium-sized factory equipped with nearly 325 modern production machine tools and equipment to ensure that the trainees attain a high degree of accuracy and skill in the various trades. They are turned out as skilled operators completely familiar with machines and equipment in the main factory.

It is intended that being acquainted with the control and operation of machines for which they are trained, the passed-out apprentices can take their place directly as workers on identical machines in the factory and need only be given a job with drawings and instruction to get on with production. The idea is that they will require the minimum amount of supervision in the shops, and with the sense of discipline and devotion to duty properly developed supervision can be reduced only to the level of administrative requirement and not watching on the rate of work effort.

The Heavy Electrical Training School and Workshop was inaugurated on 31 December, 1958, with an intake of the first batch of 964 trainees in all categories thus: Graduate apprentices, both electrical and mechanical, to qualify for posts in engineering, manufacturing and commercial departments; Technical apprentices, electrical and mechanical diploma holders for past-training employment in junior engineering and manufacturing supervisory positions; Draughtsmen apprentices; Artisan or Trade apprentices in the trades of fitting and assembly, turning, machining, tool room, welding sheet metal, blacksmithy, patternmaking, moulding and core-making, coils and armature winding; and Instructors.

STAFF SHORTAGE

There is indeed a real dearth of instructors in India. The quality required here is sound practical knowledge coupled with the ability to teach the theory of a craft, workshop practice and production methods. They must, moreover, be equipped with knowledge of the modern technique of teaching and assessment of pupils, etc. The Central Training Institute for Instructors was established by the Government at Koni-Bilaspur in 1948, as it was then realised to be an urgent and indispensable need of its scheme for training craftsmen for future industrial development of India.

This institution serves the purpose of improving the efficiency of instructors by giving them a course of theory and practice in turn in their respective trades, as well as of training new instructors and providing refresher courses. Diploma holders with good mechanical aptitude and skill could fill the role of instructors following a course of training in the above Institute. There are also other categories of persons who could be recruited for the purpose, such as the passed engineering apprentices from the Technical Schools, Railways and Ordnance factories in so far as they may be available. Whatever success has been achieved so far in the Training School is due largely to Heavy Electrical's policy of careful selection and training of instructors.

INTENSIFIED COURSES

The course offered by the established engineering institutions in India produces skilled workers to the standard required. They get all round basic training followed by specialisation in specific trades. The highly skilled work of jigs, tools and gauges where required in the mechanical engineering industry is found to be up to the best standards. In the larger interests of establishing a new engineering industry in the country Heavy Electricals had recourse to tapping the existing resources to a certain extent to create the nucleus of highly skilled personnel. To meet the requirements of a large body of draughtsmen and skilled labour it was decided to accept the passed out trainees from the ITI's as the basic material for advanced training. The standard of drawing work and craftsmanship seen at different training centres in India is satisfactory for general work in a factory.

In the case of Heavy Electricals it was felt necessary to introduce intensified courses on electric machine windings, manufacture and assembly of commutators, slip rings, brush-gear and switch gear parts, etc. Actual practice of machine and apparatus fitting and assembly can be properly acquired in the manufacturing stage, but as far as possible some arrangements had to be made to impart basic knowledge with the help of models, scrap machines and equipment.

LIVING IN

It was further concluded from a study of the existing position that the maximum period of training that could be profitably given prior to opening of the first phase of the factory was two years, beyond which training on the job is essential.

The HE Training School is of the residential type with five permanent hostels to accommodate over 1,000 apprentices, and provided with all amenities like kitchen and dining halls, recreation rooms and living rooms all suitably furnished. Accommodation for another 2,000 persons is provided in residential blocks of houses with ancillary buildings to provide the same facilities. The hostels are under the care and control of a chief warden assisted by a number of assistant wardens to run some 15 units of 200 apprentices each. Recreational facilities, sports and physical training are provided in full measure, and every effort has been made to ensure that the young men coming from different parts of the sub-continent live under conditions congenial for the growth of healthy corporate life. There is also cultural education for the trainees in languages, general knowledge and current affairs, documentary film shows and the life, in addition to subjects of mathematics, science and technology. The inspiration behind this, the largest and best equipped training school in India and ranking high by world standards, came from Sir Willis Jackson, FRS.

On the Shelf

By Frank H. Smith

I AM never quite sure if *St. Matthew*, xiii, 57 (don't trouble to look it up—"A prophet is not without honour, save in his own country, and in his own house") applies to F. W. Lanchester or not. To most people of my age the name conjures up a low-built motor car with an R-R type bonnet but to some he is known as almost the father of aerodynamics and almost certainly the man who put that science on the map in this country. In German aeronautical circles he is held in higher esteem even than in this country. A biography of this remarkable man has been written by P. W. Kingsford and is published by Arnold at 30*s*. The acknowledgments in the preface and the list of references at the end of the book are evidence of the painstaking methods of the author. I for one would certainly not like to undertake such a work for 30*s*, but the publishers are to be commended for what must be an attempt to popularise this type of biography.

The first number of the first volume of *Common Market* appeared in November last. Its explanatory sub-title is "a monthly review of European Integration and Economic Development," and in a covering letter the director says that you will find the answers to the question "What is happening in and around the Common Market?" in its pages. On the assumption that its readers are busy men, a promise is made that no issue will exceed 16 pages and in these days of *The Sunday Times* and the *Observer* this strikes me as an original gimmick. Europe and Britain pay $10 per annum for these 12 times 16 pages, and elsewhere pay another $2 for airmail. Address? Common Market, Lange Voorhout 23, POB 176, The Hague. I am rapidly gaining the impression that Holland is one large publishing company.

The word "bibliography" is to me like a traffic light on a deserted road at 2 o'clock in the morning. It sticks out a mile—or more. Thus I find in the journal *The Quality Engineer* (journal of the Institution of Engineering Inspection) a bibliography on quality control and related statistical topics. Mind you, it's one of the most unimpressive bibliographies I've ever seen, being little more than sparsely-detailed references, but there are 55 of them which isn't bad for the subject. No dates, no prices—just author, title, publisher.

The Kingston-upon-Hull public libraries have also taken quality control for their specialist subject, for the month of November last. This strikes me as quite a coincidence in view of the fact that at the same time I made a note of the bibliography in *The Quality Engineer*.

I see that the American Society for Testing Materials (1916 Race Street, Philadelphia, but I believe BSI will act as agent) has brought out another of those Special Technical Publications which I hold in such high esteem. It is No. 291 and is entitled "Elevated Temperature Properties of Aluminum (*sic*, of course) and Magnesium Alloys," and the 308 pages cost $7. This body (as I think I have remarked before) has 85 technical committees and from January 30 to February 3 is holding an ASTM Committee week (in Cincinnati) when 30 of the committees will meet. One can just imagine a member telling his wife that he was attending a committee meeting in Cin., and dodging the subsequent blow with a skillet.

I am, by now, a bit late with my news but you probably all know about the Information Scientists' course at Northampton College of Advanced Technology. It starts on 24 January and particulars are obtainable from Mr. Information Scientist himself: J. Farradane, "Torran," Crofton Road, Orpington, Kent.

A recent sit. vac. ad. was for a job at Gillette Industries, and they offered "a generous starting salary and fringe benefits." "Fringe" is hardly appropriate with all those razor blades about.

Short Cuts to Optimum

Chemical Processing Nomographs. Edited by DALE S. DAVIS. *Chemical Publishing Company, 212 Fifth Avenue, New York 10, New York.* ($12)

A process plant for the manufacture of industrial chemicals should have at least one characteristic in common with a work of art—unity. It should ideally be so arranged, and its components so designed, that nothing is superfluous, yet everything needed is present. Nothing should be too large, and certainly nothing too small for the consistent and reliable achievement of its designed capacity. Its parts should be constructed for ease of maintenance, and factors of safety should be chosen in accordance with the conditions likely to arise during operation, so that the plant can meet its owner's requirements in regard to availability, yet do so as economically as possible.

At the present time, many chemical process plants are designed, built and commissioned by chemical plant contractors to meet the production requirements of the factory owner. It is the job of the contractor to secure the order for the work in open competition with rival organisations, and it is in the best interests of the owner to award the contract to the contractor offering the process plant which will consistently produce the cheapest product having the specified characteristics—the ultimate product cost, which is the criterion, being arrived at after adding together all the cost factors and deducting credits for byproducts.

In assessing the relative merits of rival processes each of which can yield the desired product, and then of the component pieces of equipment required to make the process function, time saved in technical calculations can make all the difference between the optimum design and one which is merely adequate or even fails to meet the requirements already described. That the importance of time saving at the design stage is appreciated by chemical engineers is indicated by the adoption of computers by many organisations.

Nomographs judiciously constructed and wisely used can, on an infinitesimally smaller outlay, save a very large proportion of the time which would otherwise be needed for computations. This statement applies with especial force in the design and drawing offices of chemical plant contractors, where the optimisation of units of process equipment can be made a specialist function, and the risk of computational errors can be practically eliminated by the use of nomographs. Nomographs in the hands of senior engineers are a valuable tool for checking the work of their juniors, and in the overall direction of the lines of attack on design problems.

In his book *Chemical Processing Nomographs*, D. S. Davis has selected 165 nomographs from those published in various issues of the American technical publication *Chemical Processing*. Professor Davis, who has been described by O. P. Kharbanda, author of *Nomograms for Chemical Engineers* (1958) as the "most prolific chemical engineering nomographer of our times," produced *Chemical Engineering Nomographs* containing 201 nomographs, in 1944. The task of selection for the book under review must have been a difficult one, since D. P. Adams' *An Index of Nomograms* (1950) listed about 1,700, of which about half relate to the chemical and process industries, and there has been plenty of time since then for enthusiasts to devise many more. Those who select nomographs for publishing in book form realise that their choice tends to be arbitrary and influenced by the selector's background and interests. For example, Professor Davis devotes a whole section (five nomographs) to pulp mill calculations, and it is not surprising to find that he is professor in the Department of Pulp and Paper Technology in the University of Alabama.

The book opens with a clearly written section on the making of nomographs including practical directions illustrated by typical examples. The otherwise high standard of writing in what is a serious and useful book is marred by an attempt at a racy or readable style which is annoying. References to Christmas presents and "Santa" are particularly out of place. The remainder comprises nomograms from which physical and chemical properties, fundamental chemical engineering data and conversion factors can be extracted very readily.

Chemical Processing Nomographs may be regarded as largely complementary to Kharbanda's book, though the information available from each overlaps a little, and readings taken from respective nomographs do not always correspond, for example, the thermal conductivity of trichlorethylene at 175° F according to Kharbanda is 0·0562 with an accuracy of ± 5 per cent, while according to Davis it is 0·062.

In an otherwise excellent nomograph on heat exchanger fouling, of value because *inter alia* it reveals in visual form the serious influence on heat transfer of surface fouling, it is a pity that, according to the chart, when the fouling resistance is 0·0005, the value of U (100) for clean tubes is indicated as rising to 110 for fouled tubes !

This book will be of considerable value to chemical engineers and chemists, engaged in process design and control, both directly as a quick reference book and as a practical manual on the preparation of nomographs for the solution of such of their problems as are amenable to this type of treatment. It might more accurately have been entitled "Nomographs from Chemical Processing Magazine."

H. D. EDWARDS

Impulse and Reaction Mathematics

Aero-Thermodynamics and Flow in Turbomachines. By M. H. VAVRA. *Wiley, New York and London.* (116*s*)

Those features of fluid flow which are associated with turbomachinery provide the subject matter of this book, which takes the form of a theoretical discussion. The fact that turbomachinery is a practical subject does not mean that a theoretical treatise is out of place. The problem here is to decide for what audience the book is suited.

A cursory glance gives the impression that the book is highly mathematical, although further acquaintance shows that it is, in turn, the very standard mathematics of fluid motion in general and then some extreme elaboration of detail for special applications. This treatment will not excite the mathematician with "applied" interests, while it will be rather formidable for even the most mature of engineering students. The extent to which the engineering student will apply himself will be very definitely dictated by assurances that the theory is widely applicable, and on this very important matter there is little information. This point will be taken up later, at the end of the review.

The first half of the book is a general discussion of fluid flow, and the presentation is rather laboured. In particular the use of dyadics as an analytical tool is wholly to be deplored. The dyadic is a stopgap and suffers all the inelegance of being one. At the point where a calculus more powerful than that of vectors is needed Cartesian tensors should be used. It is not an argument to say that because tensors of higher order than the second are not needed, the use of

tensor calculus is inappropriate. For the suffix notation alone the tensor calculus will justify itself, since patterns of symmetry and asymmetry are clearly revealed during derivations, and the extensions of Gauss's and Stokes's theorems appear almost automatically. In addition there is no better way of being confirmed in the understanding and manipulation of vectors than in learning the use of tensors.

There is however a more basic consideration than the choice between dyadics and tensors, and that is whether or not there is any need at all for this part of the work to be in the book. It can readily be conceded that there is need, somewhere, to present a mathematically exact study (as far as possible) of the basic material of any engineering subject in rather more generality and depth than most applications appear to need. If this study is not made, any slight widening of the terms of reference of a particular application will appear to present insuperable problems—as may prove to be the case. But it is impossible to know until the wider implications of the mathematical model are found. The right degree of generality and depth is difficult to decide, but the extent to which they are carried in this book is excessive.

Much more use of references to standard mathematical texts on hydrodynamics and aerodynamics would have been quite appropriate. We have surely reached the stage where it is not necessary for every book within the wide field of fluid mechanics applications to re-derive the Navier-Stokes equations, the Biot-Savart law of induced velocity, the field theorems relating to vorticity and circulation and so on. These results are scarcely ever used in their complete generality but in order to get them in general form the procedures are lengthy, and in this case the author feels that it is necessary to give an 80 page appendix on vectors and dyadics, much of which will only be used to derive these very standard results.

The chapters on the applications of flow theory to turbomachinery maintain a mathematically more rigorous outlook than is usual. Also, in the early stages, the author resists the temptation to introduce simplifying assumptions about the nature of the flow merely in order to get simpler equations. Then, from equations of quite wide application, the usual special cases are quickly obtained. Such a method does not make for easy reading but this section supplies a much needed source of reliable theory, and is thus the really valuable part of the book. With such a good basis, it is a great pity that the problem of the relation between the mathematical model and the physical reality is not given much greater space and prominence.

There is being steadily built up a body of design and test knowledge in relation to turbomachinery. There is also a number of mathematical models of the flow through cascades, the flow through curved channels, the flow due to various vortex patterns, etc., and on the whole these involve lengthy, complicated analyses. The need now is for a correlation between these two classes of information. It is particularly important to know which mathematical model is the most appropriate one in given physical circumstances, and even more important to know how simple a mathematical model is permissible, still giving the required degree of correlation. The author of this book is aware of the need here, and at various points relates theory to practice, but the problem as a whole is not discussed. A survey of the validity of the various mathematical models will be the next major step in developing the study of turbomachinery.

Typographically this book is excellent and the diagrams are outstandingly good, they make a positive contribution to the understanding of the mathematical theory. As a source book for the postgraduate student or research worker it contains a body of valuable theoretical work not to be found elsewhere. Unfortunately as already indicated, a considerable part of the book is not really necessary to the advanced student. This makes the price of the book, already high, effectively higher.

R. G. TAYLOR

The Panorama of Reactor Studies

Technology, Engineering and Safety. Volume 2. Edited by R. HURST, R. N. LYON and C. M. NICHOLLS. Progress in Nuclear Energy, Series 4. *Pergamon Press.* (105*s*)

The task of making a representative selection of some 30 papers from over 400 on a given range of subjects is a formidable one. Its success depends largely on the care with which the editors define the basis of their choice. This book is a collection of papers presented to the Second International Conference on the Peaceful Uses of Atomic Energy, held at Geneva in 1958. The papers have been selected under five main headings: Reactor Chemistry, Reactor Materials, Engineering Experience and Practice, Engineering Studies, and Engineering Aspects of Reactor Safety; a complete numerical list of papers presented to the conference under these broad headings is also included.

The papers chosen for the book consist of twenty-one from the United States, seven from the United Kingdom, two from the Soviet Union, and one each from Canada, Sweden, France and Belgium. For those interested in statistics, approximately 450 papers are listed in the book, of which about 30 per cent are from the USA, about 10 per cent each from the UK, USSR and France, and about 2 per cent each from Canada, Sweden and Belgium. This does not imply that the selection of papers has been biased; but it does indicate that the book is intended to give a general picture of the fields being investigated, rather than assessing the total effort being applied to any one reactor system throughout the world. Thus, the selection of a majority of American papers confirms the fact that the United States is investigating a very wide variety of reactor systems.

The problems involved in selecting the papers are formidable, but the editors have, in the main, acquitted themselves well. The book is at its best when considering problems that are either of a general nature, or of a type common to several reactor systems. This result is to be expected and it is stated in the editors' introduction that review papers have been favoured. Unfortunately, not enough review papers were presented and the book therefore tends to be uneven, only scratching the surface at some points and delving deep at others.

The sections entitled Reactor Materials, Engineering Aspects of Reactor Safety, and Engineering Studies fall into the general category and are of a good overall standard. The titles of the first two are self-explanatory and the Engineering Studies section covers problems associated with the overall design of the plant. In each of these sections the book provides a useful summary of the immediate problems and gives a hint of possible future developments.

Under the heading Engineering Experience and Practice there are three useful papers on the problems involved in the design of irradiation experiments. However, I feel that the inclusion of three papers, out of eight in the section, on liquid-metal fuel is out of proportion. It is worth noting that no paper on the gas-cooled graphite-moderated type of reactor is included in this section. Similarly the section on Reactor Chemistry contains three papers, again out of eight, on liquid-metal fuel. But, in this case the overall balance is better.

Before summarising the overall impression, it is worthwhile to consider the usefulness of such a collection of scientific papers. These papers are of an advanced technical nature, in that they describe recent developments. Thus they are mainly of interest to the people currently working in the field. It can be argued that these people will have available the complete proceedings of the conference and that this volume is therefore superfluous. However, it is useful to people for whom access to the complete proceedings is difficult.

The editors have, in general, succeeded in presenting a reasonably balanced and interesting selection of papers, but their success is limited by the fundamental objection to this type of book. But, coupled with Volume I of the *Technology, Engineering and Safety* series, this publication provides an advanced-level reference work, which covers in some 1,000 pages the wide variety of technical and engineering problems, and their solutions, accumulated by nuclear research establishments throughout the world. It also provides a good starting point for finding information by means of the references associated with each paper.

W. G. LITTLEJOHN

No Intermediate Losses

Direct Conversion of Heat to Electricity. Edited by JOSEPH KAYE and JOHN A. WELSH. *John Wiley, New York and London.* (70*s*)

The Dynamic Behaviour of Thermoelectric Devices. By PAUL E. GRAY. *The Technology Press of Massachusetts Institute of Technology, and John Wiley, New York and London.* (28*s*)

Direct methods for generating electricity have engaged man's interest over many decades. Present techniques of utilising the available energy from fossil fuels or the fission of radioactive species for large-scale electrical power are inefficient because of the many stages of energy transfer involved, each stage with its attendant losses. If it becomes possible to go from heat energy directly to electrical power, eliminating a number of stages and reducing the volume of equipment required, much will be gained.

Direct generation systems with high overall efficiency and reduced complexity compared with conventional plant will offer the prospect of lower capital, fuel and operating costs, thus lowering the net cost of power. For applications other than large-scale power, direct generation brings, in many instances, advantages in terms of size, weight and reliability over conventional techniques based on heat engines and rotary generators, or primary and secondary batteries.

Four main methods for the direct generation of electricity are at present being considered: thermoelectric, depending on the Seebeck effect in semiconductor materials; thermionic, depending on the emission of electrons from a heated surface; magnetohydrodynamic, depending on the interaction of an electrically-conducting fluid with a magnetic field; and the electro-

chemical fuel cell, in which the process of electrolysis is reversed. In the first three "heat" as such is converted to electricity and the Carnot limit of efficiency applies; in the fuel cell the energy of a chemical reaction is converted to electrical energy and the Carnot limit does not apply, so that thermal efficiencies approaching 100 per cent are potentially available.

Direct Conversion of Heat to Electricity, edited by Professor Joseph Kaye and Assistant Professor John A. Welsh of the Massachusetts Institute of Technology, is the first attempt to bring together reports of work on direct generation in the United States. It is based on the contributions to a Special Summer Programme held in the Department of Mechanical Engineering of the Massachusetts Institute of Technology in July, 1959. The editors have assembled the papers given at this meeting and, in their own words, "have not attempted to criticise the work of the contributors or to combine and reorganise the papers into one homogeneous story." The reason for assembling the book so hurriedly is stated to be the need to provide an urgently-required starting point for new workers in this field and a convenient reference for those already in it. The surprising feature of the book is that no less than seventeen of the twenty-three chapters are reprints of papers from well-known and readily-available sources. One expects that workers in this field would already have studied these contributions, and that the newcomers would benefit by some "criticism, combination and reorganisation" in presenting the numerous theories and available experimental data.

Most of the book is devoted to work on thermionic and thermoelectric devices but there are two chapters on magnetohydrodynamic converters and one on fuel cells. Strictly speaking, fuel cells should not be included, unless the meaning of "heat to electricity" can embrace the heat of formation in a chemical reaction. However, J. F. Yeager, of the Union Carbide Consumer Product Company, presents an excellent review of the present-state-of-the-art of fuel cells as energy converters, which will be really useful to the scientist who wishes to be informed on this subject; a list of 33 references to important papers on fuel cells is given.

F. E. Jaumot, of the General Motors Corporation, gives a very comprehensive review of thermoelectric effects, practical problems, applications and theory. He includes a bibliography of 117 references. The other chapters, with the exception of one dealing with a thermoelectric *cooler* (one wonders how this one got in), provide useful information on experimental techniques and give results so far achieved. Two unfortunate inconsistencies should be mentioned: the Seebeck coefficient (α volt per ° K) of a semiconductor material is often referred to as the "thermoelectric power"; and the "figure of merit" ($\alpha^2\sigma/k$, where σ and k are the electrical and thermal conductivities respectively) is sometimes given units of "° C^{-1}" instead of "° K^{-1}."

Eleven chapters on thermionic "engines" demonstrate that the mechanism and theory of the thermionic diode generator are not completely understood, however well the theoretical curves and experimental data agree in many cases. The effect of a space charge which limits the electron current passing from the hot cathode to the cool anode has to be overcome before high power output can be achieved. A number of techniques for surmounting the space-charge limitation are being investigated; they include reducing the interelectrode spacing (in vacuo) to less than 0·001 cm, introducing positive ions (usually caesium vapour) to neutralise the electron cloud forming the space charge, and the use of auxiliary fields to guide the electrons. G. N. Hatsopoulos, of the Massachusetts Institute of Technology, puts forward an interesting analysis in which thermoelectric and thermionic devices are shown to have analogous parameters, deriving finally a comparison between a thermionic and thermoelectric "figure of merit."

In conclusion, it may be said that this book is the first (no doubt of many) in which a survey of direct generation research is attempted. The scientist already working in this field will find little that is new but may consider that the assembly of the already-familiar papers in one cover will justify its purchase; the new worker, unless he is familiar with allied technologies, may find the collection of unrelated papers a little confusing. The book itself is well produced; each chapter has a carefully-compiled list of symbols and the references are exceptionally comprehensive.

Paul Gray's book is one of a new series published jointly by the Technology Press of the Massachusetts Institute of Technology and John Wiley. These books are reports of research studies larger in scope than a journal article but less ambitious than a finished book. Frequently such studies are embodied in a form which is not widely disseminated, perhaps as a university thesis or as a laboratory report. Publication in monograph form ensures that such research studies find their proper place in the literature of the field and that the work is readily accessible through libraries and to the independent worker.

This study is essentially for the specialist. The technology of thermoelectric generators and heat pumps has advanced to the stage at which small devices are being put to specialised practical application. The present work considers the dynamic behaviour of such devices and the effect on possible control systems. The introduction contains a particularly lucid account of thermoelectric effects, describes the types of device which utilise these effects, explains the existing knowledge of static and dynamic behaviour, and concludes with a careful statement of the scope of the study.

In the chapters which follow, the mathematical characterisation of the device is explained, small-signal analyses for the heat pump and thermoelectric generator are developed, and details are given of experimental measurements on a simple heat pump. In the final conclusions the study is summarised and recommendations are given for future work.

B. C. LINDLEY

New Books

Progress in Semiconductors: Volume 5. Edited by ALAN F. GIBSON, R. E. BURGESS and F. A. KRÖGER. *Heywood.* (63*s*)

The seven critical reviews in the present volume cover electrical properties, the absorption edge spectrum, chemical bond, thermal conductivity, magneto-optical phenomena, indium antimonide, and the band structure and electronic properties of graphite crystals.

Hyperstatic Structures. By J. A. L. MATHESON and A. J. FRANCIS. Volume 2. *Butterworths Scientific Publications.* (60*s*)

This second volume is made up of worked examples and problems applying the principles and methods discussed in volume I. The theory has not been expounded again in full, but in most cases the chapters are prefaced by one or more examples, usually more complex than their counterparts in volume I.

Resonance Absorption in Nuclear Reactors. By LAWRENCE DRESNER. *Pergamon Press.* (40*s*)

The author has adopted an unusual method to attain a combination of a readable account of his subject and a comprehensive and systematic treatise: following an historical review, the entire text has been divided into sections, and the simplified version may be obtained by omitting the reading of sections marked with an asterisk.

Betriebstechnik: Verfahren und Operationen. Dechema Monographien, Band 33. *Published for Deutsche Gesellschaft für Chemisches Apparatewesen by Verlag Chemie, Weinheim/Bergstrasse.* (37·50 *DM*; members 30 *DM*)

The second of three volumes of papers presented at the European Congress of Chemical Engineering and the 2nd ACHEMA Congress, including contributions on new methods for the production of hydrocyanic, acetic and phosphoric acids, synthesis gas, tantalum and niobium, as well as specially purified manganese and silicon. An account is also given of progress in plant design.

Trade Publications

Copies of any of the following trade publications are obtainable from the addresses given, though distribution is sometimes restricted.

Office Equipment

Adhesive Labels. GORDON & GOTCH (SELLOTAPE) LTD., 8-10 Paul Street, London, EC2. Self adhesive labels for office, factory and shop. Booklet. 14 pp., ill.

Dictating Machine. FONADEK (BRANSON) LTD., Knightsdowne House, Harbourne, Birmingham 17. The DG4 dictating machine with foot control and remote control microphone. Leaflet, ill.

Drawing Office. HALL HARDING LTD., Stourton House, Dacre Street, London, SW1. Equipment for the drawing office. Tables, benches, chairs, machines, and cupboards. Catalogue, 130 pp., ill.

Furniture. EDGLEYS LTD., 151 Fleet Street, London, EC4. Desks, chairs, typewriters, filing cabinets, calendars, ash trays, etc. Both unit and custom built series. Catalogue, 52 pp., ill.

Branch Exchange. AUTOMATIC TELEPHONE & ELECTRIC CO. LTD., Strowger House, Arundel Street, London, WC2. Private automatic telephone exchange type 58 for use in systems covered by MOP certificate I.S. 1142 (Methane). Leaflet, 4 pp., ill.

Equipment. OFFICE EQUIPMENT CO. LTD., 113 High Holborn, London, WC1. Chairs, tables, and desks for office or board room, wood or steel, new and secondhand; also cabinets, typewriters, and adding machines. Catalogue, 28 pp., ill.

Filing Cabinet. TIPDEX LTD., Green Lane, Hounslow, Middx. Space saving filing cabinets with easy access. Folder, 4 pp., ill.

Charts. ADAPTA-CHARTS LTD., 129 Hammersmith Road, London, W14. The range of Movigraph charts and panels for progressing and recording shown in use. Brochure, 16 pp., ill.

Office Furniture. GLENHILL (OFFICE FURNITURE) LTD., Green Lane, Hounslow, Middx. Stools drawing boards, tables, and chairs, new and reconditioned; safes, lockers, and trays. Price list and catalogue, 12 pp., ill.

Drawing Copier. RANK-XEROX LTD., 33-41 Mortimer Street, London, W1. Unitised micro film system for storing drawings using Copyflo printers. Leaflet No. RX 57, 4 pp., ill.

The Reviewers

Mr. H. D. Edwards, B.Sc., A.R.C.S. (Chemistry), D.I.C., M.Sc. (Chemical Engineering), M.I.Chem.E., has recently taken up an appointment as consultant to the Shaw Wallace Group of Companies, Calcutta. He was previously a senior project engineer with Chemical Construction (G.B.) Limited.

Dr. R. Graham Taylor, A.F.R.Ae.S., is a lecturer in the Mechanical Engineering Department of Imperial College, University of London. Academically qualified in mathematics and applied mathematics, Dr. Taylor was engaged in operational research for the Admiralty during the war and was later a member of Armstrong Siddeley's Gas Turbine Research Section.

Mr. W. G. Littlejohn is lecturer in the Department of Nuclear Engineering in the University of Manchester. He previously served three years with the Nuclear Power Plant Company, which recently became part of the Nuclear Power Group.

Dr. Bryan C. Lindley is leader of the Future Studies Section at the Nuclear Research Centre of C. A. Parsons and Company Limited, Newcastle upon Tyne, where he is engaged in theoretical and experimental work on direct generation systems and other projects. He previously conducted similar investigations while serving with the Hawker Siddeley Nuclear Power Company, and was also responsible for overall assessment studies on marine, aircraft and rocket nuclear propulsion systems. Earlier he had carried out research on combustion in the Mechanical Engineering Department, University College, London, and on the suppression of explosions at the National Gas Turbine Establishment.

Marketing

Contracts at Scunthorpe and Ravenscraig for GEC

Two ore-handling plants, worth between them £1¼ million, are to be built by GENERAL ELECTRIC for the APPLEBY-FRODINGHAM STEEL Company and for COLVILLES.

The order for Appleby-Frodingham, received through HEAD WRIGHTSON IRON AND STEEL WORKS ENGINEERING Limited, is for an eight bed blending plant and some 15,000 ft of conveying equipment for the sinter plant. This new installation, worth £1 million and to be located at the Scunthorpe South works, will supplement the original plants supplied by GEC and commissioned in 1950 and 1954.

For Colvilles, the £500,000 contract covers three orders for the ore-handling plant at the Ravenscraig works, Motherwell. One order, placed directly by Colvilles, is for stockyard extensions and modifications including a 170 ft span stocking-out bridge and two double-rotor plough feeders. The feeders are of new design and each one is able to handle 1,500 tons of ore an hour.

The other orders include one placed through Head Wrightson Iron and Steel Works engineering for conveying equipment for a sinter plant and another for limestone and lime-handling plant for which PRIEST FURNACES are the main contractor.

Generating Plant Installed in 1960

The CENTRAL ELECTRICITY GENERATING BOARD installed a record amount of new electricity generating plant last year. In all, 1,935 MW, equivalent to 2,500,000 hp, were added to the output capacity.

Altogether 21 turbo-generators, with a combined capacity of 2,060 MW, and 22 boilers, of a total evaporative capacity of 15,890,000 lb of steam per hour, were installed in 14 power stations, four of them new stations. Details are given in the table below.

Two more 200 MW units (installed capacity) were brought into service at High Marnham power station on the Trent. This is the largest size of unit yet operated by the CEGB.

In this lies one of the keys to the table. The amount of generating plant stands at a record. But, as efficiencies and output from plants grow, so the number of units required dwindles, sharpening the competition between manufacturers; and, with the heavy costs of research and development, increasing the difficulties of those who do not win through to the big contracts.

Anglo-German-French Military Air Transport

Britain, France and West Germany are working together on the new military transport, the twin turboprop Transall C-160.

ROLLS-ROYCE have been awarded the contract, worth about £875,000, for Tyne engines for the three prototypes, which are expected to be flying in the development programme of the new transport early in 1962.

The West German Defence Ministry spokesman who announced the contract with Rolls-Royce stated that if the prototypes are successful about 200 C-160s may be ordered for the West German forces.

The new aircraft is intended to fly at well above 250 mph and to carry eight tons. These figures give it a greater weight carrying capacity and better speeds than the French Noratlas transport which it will succeed.

A feature of the transport will be its ten-wheel undercarriage which will make operations possible from relatively rough country.

NORDAVIATION of France and the West German company WESER AND HAMBURGER are also working on the project.

More Effort Needed by Car Salesmen?

Lively criticism of car salesmen in this country has come from Mr. W. R. Bowden, the national chairman of the INSTITUTE OF MARKETING AND SALES MANAGEMENT, who says that even in the present depression of sales, salesmen appear to be sitting in shiny salesrooms waiting for the customers to walk in and place their orders.

Mr. Bowden wonders what the sales position would be if the salesmen got the soles of their shoes more polished than their trouser seats. His question—is it not time that industry spent more money on sales training and advertising, at least at a rate comparable with that which has been spent in the fields of science and technology—perhaps begs the question.

For while more effective spending could plainly be carried on for science and technology as well as sales and marketing, there are firms whose spending on research and development nowhere approaches their expenditure on sales and marketing.

Bonds to Boost USA Car Sales

The AMERICAN MOTORS CORPORATION has decided to give very practical recognition to the dependance of a company's prosperity upon its customers. AMC is to give everyone who bought a Rambler or Metropolitan model in December a $25 savings bond.

American Motors, who have earned a reputation for trend setting in the United States car industry, are going a good deal further with this scheme than just giving away one savings bond. By means of a four month progress sharing scheme the value of the bonds is to increase in each month that the sales of AMC are ten per cent above the same month last year. This means that if the sales go on rising through each month compared with 1960 the buyer of a Rambler or Metropolitan in March will be given a $125 savings bond.

Volkswagen Winning the Car Export Stakes

Perhaps the brightest of all the stars in the West German industrial firmament is the VOLKSWAGEN firm, pouring out the celebrated beetle-shaped vehicle from their plant at Wolfsburg, near Hanover.

Production last year was 890,000, which was more than 200,000 above the 1959 level. Now the production rate has been lifted to 4,000 cars every 24 hours and enthusiastic efforts to raise this are being pursued. Of last year's immense output 60 per cent went abroad, some two-thirds of the total going to the United States market, despite the impact of the compact cars.

Against the trend, Volkswagen increased their US sales by 37 per cent in the year that total car imports into America fell off by 27 per cent. Demand is also maintained in Scandinavia and in the nearby Netherlands.

All this activity has led to a 10,000 increase, to 65,000, in the number of employees over the last twelve months. 1960's turnover reached £330 million.

Modernisation Increases Wear Shipyard Orders

The connection between the £10 million spent since the end of the war on the modernisation of shipyards on the River Wear and the 25 orders placed on the river last year, with another six in prospect, has been drawn in a review of Sunderland ship building by Colonel R. A. Bartram, the chairman of the WEAR SHIPBUILDERS ASSOCIATION.

Less cheering is the fact pointed out by Colonel Bartram that in the face of intensive competition most, if not all, of the orders were taken at uneconomic prices. Though the level of orders was appreciably better than the average position in the British shipyards it was still not quite equal to the number of ships launched during 1960.

£2¼ Million Contract for ESC's Tinsley Park

The ENGLISH STEEL CORPORATION'S new £26 million Tinsley Park works are to have rolling mills produced by two Sheffield companies acting together. The two firms awarded the £2,250,000 contract for the mills are DAVY AND UNITED ENGINEERING Company (members of the DAVY-ASHMORE GROUP) and the BRIGHTSIDE FOUNDRY AND ENGINEERING Company (members of the BRIGHTSIDE GROUP).

When English Steel have completed their Tinsley Park scheme it will be the largest single industrial undertaking in the city of Sheffield.

Power Station Construction by the Central Electricity Generating Board in 1960

The plants listed, complete with ancillary equipment, were commissioned during 1960

Power station	CEGB project group	Turbo-generator plant		Boiler plant		Main high pressure pipework
		Installed capacity in megawatts	Maker	Capacity in lb per hr	Maker	Maker
Aberthaw*	Midlands	2 × 100	C. A. Parsons	2 × 755,000	Foster Wheeler	Stewarts and Lloyds
Agecroft C	Northern	1 × 120	Associated Electrical Industries	1 × 860,000	International Combustion	Stewarts and Lloyds
Belvedere LP	Southern	1 × 60	English Electric	1 × 550,000	John Brown	Aiton
Blyth A	Northern	1 × 120	Associated Electrical Industries	1 × 860,000	Babcock & Wilcox	Babcock and Wilcox
Bold B	Northern	1 × 60	General Electric	1 × 550,000	John Thompson	John Thompson
Drakelow B	Midlands	2 × 120	C. A. Parsons	2 × 860,000	Foster Wheeler	John Thompson
Elland	Northern	1 × 60	Associated Electrical Industries	1 × 550,000	John Brown	John Thompson
High Marnham	Midlands/Northern	2 × 200	English Electric	2 × 1,400,000	International Combustion	Aiton
Northfleet*	Southern	3 × 120	General Electric	3 × 860,000	Foster Wheeler	Babcock and Wilcox
Plymouth B HP†	Southern	2 × 60	Associated Electrical Industries	2 × 550,000	Babcock and Wilcox	John Thompson
Skelton Grange B*	Northern	1 × 120	C. A. Parsons	1 × 860,000	Mitchell Engineering	Aiton
South Denes	Southern	1 × 60	Richardsons Westgarth	1 × 550,000	Mitchell Engineering	John Thompson
Spondon H	Midlands	2 × 10	Associated Electrical Industries	3 × 180,000	Foster Wheeler	Aiton
Staythorpe B*	Midlands	1 × 120	Associated Electrical Industries	1 × 860,000	John Brown	Babcock and Wilcox
14 Stations including 4 New stations and 1 New section	3 Project groups	21 Turbo-generators having an aggregate installed capacity of 2,060 MW		22 Boilers having an aggregate installed capacity of 15,890,000 lb per hr		

In addition to the above, the following boilers have been completed but not commissioned as the associated turbo-generators are not yet available:
Belvedere HP, Boiler No. 5—860,000 lb per hr capacity, manufactured by John Brown
Rugeley, Boiler No. 1—860,000 lb per hr capacity, manufactured by Babcock and Wilcox

* New stations in which plant has been commissioned for the first time in 1960.
The power stations whose names are marked thus † are new sections, and the remainder are existing stations to which extensions have been made.

Power Plant and Prime Movers

Conventional and nuclear power stations; experimental nuclear reactors; electric, diesel and diesel-electric power units; gas-turbines, industrial engines, boilers and boilerhouse plant; switchgear and transformers; pumps and compressors, hydraulic turbines and turbogenerators.

SOME of the most interesting work in 1961 lies in developments in advanced nuclear reactors in Britain and on the Continent, in high voltage transmission activities in the Soviet Union, the United States and this country, and in the continuing improvements in the efficiency of conventional power stations.

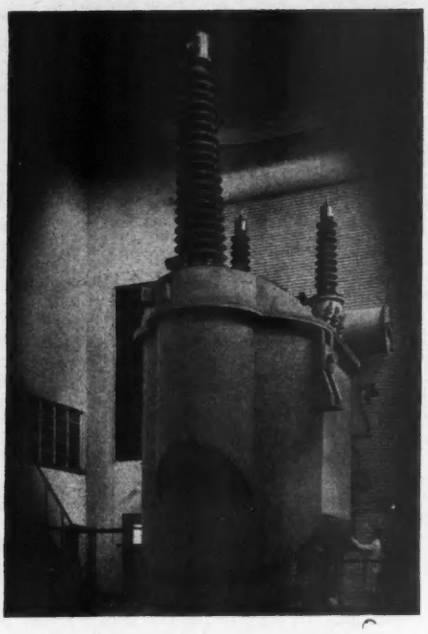
Design and Development

An important feature on the nuclear horizon in 1961, which BEAMA have termed "Electrical Year," will be the completion or near-completion of the advanced gas cooled reactor being built at Windscale by the Atomic Energy Authority with a view to making practicable a considerable advance in outlet gas temperatures. It is only by increasing the temperature of the gas through the type of gas-cooled natural uranium fuelled graphite moderated reactors on which the British programme is based that lowered capital cost can be expected. There will undoubtedly be new canning methods adopted for the stations at Oldbury and Sizewell, of which details will be given during the coming year, and these will be aimed at allowing higher temperatures to be employed. Higher heat outputs for a given size of core and higher maximum can surface temperatures will both be expected during the year. But it is unlikely, either in Britain or elsewhere, that any new reactor designs will be evolved on a commercial scale.

In Holland it is likely that there will be in commission during the year a type of reactor not used elsewhere: the homogeneous suspension reactor in which uranium is in a solution so that the water acts as both coolant and moderator. The Dutch feel that this type of reactor, which has not found favour elsewhere, may well lead to the evolution of cheaper reactor designs, and they are building a 500 kW experimental unit which is shortly to be commissioned, with a 20 MW unit being planned.

But if the outlook for nuclear plant, in the world as a whole, is somewhat disappointing (though Sir Christopher Hinton in Britain continues to reaffirm his faith in nuclear power as an eventual economic means of supplementing conventional sources of energy) what of the conventional stations and the rapid rises in efficiency which have characterised their history during recent years? At the moment, somewhere about 650 MW is the largest size of generating unit on order, and these are only planned for American stations. However, in Britain we have the announcement by the Central Electricity Generating Board that the minimum size of unit they are likely to order in future is 500 MW and that the "standard" conventional stations of the future will be 2,000 MW, with four of these units.

The efficiency of the steam cycle has been driven to a stage approaching its limit. Breaching this limit now lies in the hands of the metallurgist.



A 330 kV single-phase transformer for the Electricity Commission, New South Wales, in the high voltage laboratory of English Electric.

There has been a retreat from the extreme high temperatures of above 1,050° F, even in America, and this is about the level of the highest temperature which at the present time is considered as practicable. Pressures, on the other hand, have risen until the supercritical sets now on order in Britain (and in operation in America) employ pressures of the order of 3,500 lb per sq. in.

One interesting development which will come to fruition in 1961 is the building of the first dry cooling tower to operate on a large scale in Britain. At Rugeley power station one of the 120 MW units is equipped with a cooling tower of this type in which the water is continually recirculated. If this large-scale experiment is successful, then in 1962 and onwards those concerned with the very difficult problem of siting the 2,000 MW stations we shall need in Britain in the future will have a slightly easier task. At present, they have to restrict their choice to those few areas of the country where there is ample coal supply at nearby collieries, and also ample cooling water. If one of these two criteria becomes less stringent, a whole new range of sites may become available.

In the design of plant for conventional steam stations or for the conventional side of nuclear stations two further advances may be forecast as taking firm hold in 1961. First, the manufacturers particularly in Britain have had to devote very great attention to the problems involved in transportation of the largest single piece of equipment of, say, a 500 MW generator.

The units coming into commission for the first time in 1961 will have direct cooling by water of the stator windings and this method, although adopted now for some years for smaller units offers very severe challenges to the engineers concerned with generator design, when the larger sizes are under consideration. The hollow conductors necessary for this purpose require great ingenuity in fabrication.

Coupled with the cooling of the rotor windings, again using hollow conductors, and the use of higher hydrogen pressures to remove greater quantities of heat, remarkable reductions in overall size for unit output have been achieved.

Secondly, the very large circulating water pumps needed for these 500 MW units themselves provide transportation problems, and during the next twelve months or so the first pump in which concrete is used for the volute will be approaching commissioning. Pumps of 300,000 gallons per minute are very large units by any standard, and this breakaway from the traditional metallic casing (but with the attendant problems of fabrication of the concrete, of resisting erosion and so on) will improve the outlook for large pumps, once the initial problems have been solved.

Future Events

It looks as if 1961 will be a vintage year in the field of electric power production. In the coming twelve months in Britain the first really commercial-scale nuclear power station, or even two power stations, will come into commission, at Bradwell and Berkeley. The largest pumped storage station in the world at Ffestiniog in North Wales will almost certainly come into partial commission, the constructional work should be well under way for the world's first tidal power scheme at Rance in Brittany, and on the exclusively electrical side the cross-Channel cable should be in service by the end of the year, while Britain's first 380 kV transmission lines should be energised, and in America work should be almost completed on the first 750 kV experimental transmission project anywhere in the world.

By the end of 1961 there will be in operation not only the Calder Hall and Chapel Cross stations of the United Kingdom Atomic Energy Authority (which are not designed primarily for the purpose of generating electrical energy economically), but in addition 575 MW of plant at Bradwell and Berkeley will be partly in commission, the remaining part very near that stage. Work will have advanced on the 500 MW Hinkley Point plant to the stage where the first reactor will be nearly ready for fuelling, and at Trawsfynydd in North Wales the 500 MW plant, and at Hunterston in Scotland the 300 MW plant, will both be well on their way towards completion. Work will have started in earnest on the Dungeness plant and it is probable that the preliminary stages of civil engineering will be in progress on the nuclear plants at Oldbury on the Severn estuary and at Sizewell on the Suffolk coast. Thus, apart from the actual commissioning of the first units, there will be 2,375 MW of plant under construction, excluding the Atomic Energy Authority's two installations. No other country has anything approaching this figure.

The cost per kilowatt of electrical output of nuclear plant in Britain has fallen from about £160 to about £110, and £90 per kilowatt is being mentioned as a possible figure for achievement during 1961. However, in the world as a whole there is still a strong feeling that nuclear plant is not yet an economical means of generating power under all circumstances. It is estimated that in Britain the date when power from nuclear sources will compare with that from conventional coal-fired stations will be about 1968.

In the United States the rapid progress in the efficiency of steam plants with supercritical units coming into commission—as in Britain—has cast a shadow over the nuclear power programme which shows no signs of lifting. A report presented recently to Congress showed that whereas national and international efforts to develop nuclear programmes had been expected rapidly to produce designs of reactor which were competitive in cost per unit output with conventional means of generating power, the result has been disappointing. The report said that no nuclear plant yet purchased for commercial service anywhere in the world was competitive. The advantages of nuclear power could only be realised if the cost was not only marginally better than that of units from coal-fired plants

but in fact showed a considerable advantage; and no reactor design or other factor in nuclear power application yet showed great promise of bringing this about.

In Russia the 800 kV Stalingrad-Donbass line, which will be 300 miles long, will be well under construction. There is also a likelihood that a decision will be made by the New Zealand government to proceed with the d.c. interconnection between the North and South Islands.

Other direct current developments are receiving active consideration in Canada, and there are schemes also under discussion in the Scandinavian countries for more links between Norway, Sweden and Denmark.

External Factors

In assessing the main influences on demand for power plant and prime movers a distinction must be made between heavy electrical generating equipment, including the associated steam turbines and boiler plant, and industrial equipment including electric motors, industrial engines, pumps and compressors. The length of time required to build and instal complete power stations involves long term planning and the rate of installation of new plant tends to remain fairly steady. Any adjustments which have to be made tend to be gradual. Demand for industrial equipment on the other hand tends to be much more sensitive to the rate of industrial expansion. Throughout 1959 and the early part of 1960 demand in this field showed a steady expansion but the balance of payment difficulties and break in confidence which became apparent towards the end of the year may result in some falling off in demand during 1961.

On the other hand export demand for the heavier types of power equipment including diesel generating sets, pumping and compressor installations has been much stronger than for large generating installations and this may well continue. Manufacturers of large generating equipment are finding it increasingly difficult to provide the long term credit necessary to achieve sales to underdeveloped countries, which provide the main markets, and the steady decline in exports of heavy electrical equipment over the last two years shows little sign of ending.

Market Trends

In spite of the disappointing trend in export markets, deliveries of electricity generating plant and of rotating electrical machines as a whole was running at a high level during 1960.

The annual programmes for new generating plant up to 1964 show that a peak figure of 2,404 MW (of which 575 MW represents nuclear plant) will be reached in 1961 after which there will be a decline to 2,271 MW in 1962 and 1,819 MW in 1963. The original programme for 1964 totalled 1,727 MW but an examination made in 1959 of the basis for long term estimates showed that the latter have shown a persistent tendency to underestimate future demand for electricity. It was therefore decided to raise the previous estimate for demand in 1964 by 1,200 MW and to meet this by prolonging the life of certain old stations to obtain 550 MW and putting in hand a supplementary programme of 650 MW. The revised programme for 1964 therefore totals 2,377 MW. Over the four years 1961 to 1964 the average rate of installation of new generating plant will therefore be about 2,236 MW, of which an average of 456 MW per annum will represent nuclear plant leaving the average for new conventional plant at 1,780 MW.

The cut in the nuclear power programme announced in the White Paper issued in June, 1960, does not affect the situation up to 1964 since the 1,825 MW of nuclear plant which will be erected by 1964 is already on order. It will increase the new conventional plant required in subsequent years. The new programme provides for the installation of about 5,000 MW of nuclear plant by 1968 as compared with the previous target of 5,000 to 6,000 MW by the end of 1966. The reasons for the cut back were given as the improvement in the supply position of both coal and oil but an additional factor has also been the marked increase in efficiency and reduction in capital cost of conventional generating plant.

Prospects for the supply of generating plant to the home market are thus reasonably good over the next few years, though the trend towards even larger generating units is creating serious problems for the electrical engineering industry.

The outlook for industrial motors seems less favourable. From a low figure of 45·7 million sq. ft in 1958 plans approved for industrial building rose to 58·4 million sq. ft in 1959 and an annual rate of 109 million sq. ft in the first six months of 1960. This, however, was a period of rapidly increasing industrial activity and in view of the present uncertainty regarding the economic future it would not be surprising if a number of plans for which approval has been obtained are put into cold storage for a period.

Some anxiety has also been expressed regarding the outlook for future sales of transformers. In evidence to the Restrictive Practices Court in November, 1960, Mr. R. M. Hobhill, general manager of the transformer division of Ferranti, said that in September, 1960, orders in hand for transformers amounted to about a year's production and showed a fall of about 11 per cent compared with two years ago. He expressed anxiety regarding the future in view of the fact that some transformers on order were not due for delivery for two or three years.

Railway electrification has for the past few years provided an important outlet for heavy electrical plant. Under the original proposals railway electrification was expected to provide a substantial market for several years to come but the manufacturers concerned have recently expressed considerable anxiety at suggestions that electrification of the section from Crewe to London may not proceed. Any alteration of existing plans would affect most seriously the manufacturers of transformers, switchgear, signalling equipment and other products associated with the electrification of the track: the effect on locomotive builders would be less marked since if electric locomotives are not provided additional diesels or diesel-electrics would be required.

TABLE I:—*UK Exports of Power Plant and Prime Movers (£ million)*

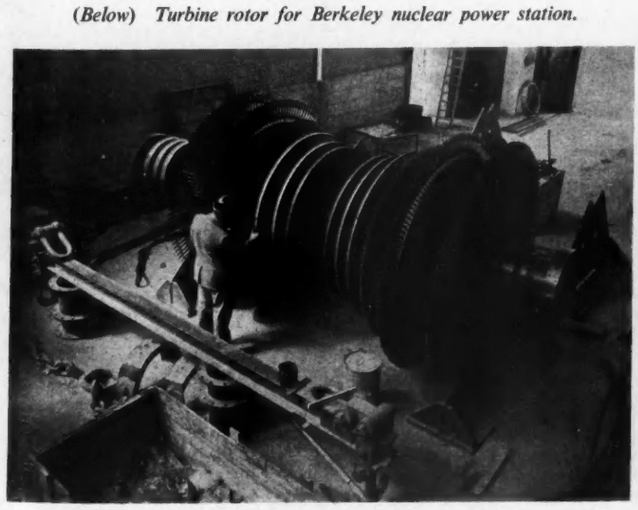
	1958	1959	1960
Electrical generating sets, generators and motors	37·4	37·3	33·7
Converting machinery, mercury arc rectifiers, transformers, switchgear and switchboards	31·5	30·8	28·0
Boilers and boiler house plant	18·5	15·1	13·6
Steam engines	8·7	11·8	15·7
Internal combustion engines (except for motor vehicles, tractors and aircraft)	33·2	32·8	34·7
Water turbines and other water engines and other power generating machinery (including gas turbines) n.e.s.	2·6	4·4	5·0
Pumps	16·9	17·1	17·7
Air and gas compressors and exhausters	5·7	6·9	8·4
Primary batteries	6·0	6·5	7·2
Secondary batteries	4·1	3·9	3·6

In general the trend of exports for electrical machinery and for boiler and boiler house plant has been disappointing for the past three years (see Table I). The value of exports of electrical generating sets, generators and motors fell from £37·4 million in 1958 to £37·3 million in 1959 and an annual rate of £33·7 million in the first nine months of 1960. Similarly exports of converting machinery, mercury arc rectifiers, transformers, switchgear and switchboards fell from £31·5 million in 1958 to £30·8 million in 1959 and an annual rate of £28·0 million in 1960, while those of boiler and boiler house plant fell from £18·5 million to £15·1 million and £13·6 million respectively.

In the case of generating sets, generators and motors the decline has been due partly to balance of payment difficulties in India which in 1959 was the largest individual market but accounted for only £2·0 million in the first nine months of 1960 compared with £3·3 million in the corresponding period of 1959. Other important markets to which exports declined in 1960 were the Union of South Africa (£2·2 million compared with £2·7 million), and the USA, which showed a similar decline. On the other hand there were increases in exports to Australia,

(Right) One of twelve 350 ton heat exchangers for Trawsfynydd nuclear power station.

(Below) Turbine rotor for Berkeley nuclear power station.



New Zealand, Canada and the Federation of Rhodesia and Nyasaland.

Exports to the USA have suffered from attempts by US manufacturers to obtain protection from imports on national Security ground. Pleas for protection against imports of both hydraulic turbines and turbo generators were however turned down last year by the Office of Civil and Defence Mobilisation. In making this ruling the OCDM said that US purchases from abroad were relatively small and that the US industry still had, and would continue to have, the capacity to meet requirements in an emergency.

It is doubtful how far this decision will assist British exports to the USA since increased competition between US manufacturers resulting from Government action against alleged price fixing has had the effect of reducing prices and US manufacturers receive a substantial "Buy American" preference.

In the case of converting machines and switchgear there was a fall in exports in 1960 to most of the principal markets including India, the Union of South Africa, Australia and Rhodesia and Nyasaland, though a satisfactory feature was an increase in exports to "other foreign countries" from £2·0 million to £4·3 million.

TABLE II:—*UK Power Plant and Prime Movers: Deliveries 1958 to 1960* (£ *million*)

	1958	1959	1960
Industrial engines	65·4	76·4	80·8
Pumps and industrial valves	83·5	87·2	91·2
Air and gas compressors and exhausters	20·5	23·0	25·2
Water tube boilers	61·2	59·5	56·6
Shell boilers and boiler house plant	25·6	25·0	28·2
Electrical machinery:			
Rotating electrical machines	122·0	128·0	132·2
Transformers for lighting, heating and power	42·0	41·9	42·2
Switchgear and control gear	107·8	108·5	114·4
Other electrical machinery	15·6	16·3	19·6
Primary batteries	12·0	12·5	12·4
Secondary batteries	22·3	23·5	26·0

In the case of boiler and boiler house plant there was a fall in exports of all types of boiler, with the exception of water tube, and in economisers, feed water heaters and steam superheaters and other boiler house plant and the decline was spread over most of the principal markets.

By contrast exports of steam engines and of industrial internal combustion engines increased in 1960. the rise in the case of steam engines being as high as 33 per cent. This was due mainly to substantially increased exports to both Canada and Australia. The bulk of these exports consist of steam turbines other than marine. The most important categories of internal combustion engines exported are compression ignition engines of less than 50 bhp though there is also an important export trade in large compression ignition engines for marine propulsion and for other purposes. Some 40 per cent of total exports in this category consist of parts of engines, including both spares and parts for assembly overseas. A relatively small category of power generating machinery for which exports have approximately doubled in the last three years is "water turbines and other water engines, and other power generating machinery (including gas-turbines)."

In June, 1960, the British Electrical and Allied Manufacturers' Association published a survey of the European common market for electrical products. This pointed out that by 1963 the six common market countries would be buying or installing electrical products at the rate of about £3,300 million per annum, an increase of 44 per cent on the 1958 figure. Over the five years 1959 to 1963 they will absorb electrical products valued at £14,000 million, equivalent to about 10 years UK output at present rates of production. Although the output of the electrical manufacturing industries in each of the Common Market countries is below that of the UK the rate of advance in France and Western Germany, and at a lower level in Italy also, is considerable. The survey reached the conclusion that the fastest growing markets for capital equipment will be in the fields of signalling equipment required for railway electrification, and in switch and protective gear.

Management and Labour

Employment in the manufacture of electrical machinery rose from 207,400 at the end of July, 1959, to 214,000 at the end of July, 1960. This represents an increase of 3·2 per cent whereas the output statistics given below show rises in production between 1959 and 1960 of 1·9 per cent in the case of rotating electrical machines, 0·7 per cent for transformers, 4·5 per cent for switchgear and control gear and 20·0 per cent for other electrical machinery. Taking all the above categories together the increase was 4·4 per cent, which is slightly higher than the increase in the labour force.

Total employment in the production of industrial engines is very much less but rose from 36,000 in July, 1959 to 37,400 a year later.

Plant and Materials Supplies

The electrical engineering industry had the advantage last year of a relatively stable market for copper with only limited fluctuation in price. UK consumption of refined copper (primary and secondary) rose from 479,000 tons in 1959 to an annual rate of 543,000 tons in the first nine months of 1960. Consumption also rose in most other important consuming countries but not in the USA where the annual rate of consumption in the early part of 1960 was slightly below the level of the previous years. There is at present more than adequate capacity for the production of copper and world output (excluding the Soviet sphere) rose from 3·5 million tons in 1959 to an annual rate of about 4·1 million tons in the first nine months of 1960. UK stocks of refined copper rose from 44,000 tons at the end of 1959 to 93,500 tons at the end of September, 1960, and consumers should experience no difficulty in obtaining adequate supplies in the current year.

Production

A new series of statistics for the value of deliveries of power plant and prime movers, issued by the Board of Trade, is shown in Table II. The trend of production of industrial engines, pumps and air and gas compressors has been steadily upwards. In the case of rotating electrical machinery (which covers generating sets, generators, motors of all types, motor generators, rotary converters and synchronous condensers but excludes dynamos for motor vehicles and cycles) expanding home demand has been sufficient to outweigh the decline in exports but water tube boilers have shown a steady decline in total deliveries over the past three years. Table III gives a further set of figures for deliveries of electrical generating plant.

TABLE III:—*UK Deliveries of Electricity Generating Plant and Rotating Electrical Machines*

	1958	1959	1960
Electricity Generating Plant			
Hydraulic turbines (million bhp)	1·03	1·75	1·20[1]
Steam turbo-alternators, 10,000 kW and over (million kW)	2·55	3·67	4·97[2]
Steam turbines less than 10,000 kW (million kW)	0·22	0·22	0·18[2]

[1] Based on deliveries for the first 3 months only.
[2] Based on deliveries for the first 6 months only.

Expansion and Investment

Electricity generation is an industry which maintains a high rate of technological progress. This has been reflected in marked increases in thermal efficiency and reduction in capital cost per kW of capacity resulting mainly from increases in the size of individual generating units installed and increases in steam pressure and temperature. A 30 MW unit commissioned in 1948 operating with steam at 600 lb per sq. in and 850° F showed a thermal efficiency of 26 per cent and the capital cost per kW sent out was £67. By 1959 units were being installed of 200 MW using steam at 2,350 lb per sq. in and 1,050° F which showed a thermal efficiency of 36 per cent and a capital cost per kW sent out of £50. For 1963 units are envisaged of 550 MW with steam conditions similar to those in the last example which are expected to show a thermal efficiency of 36·5 per cent and to cost £39 per kW sent out. When account is taken of the fall in the value of money since 1948 the reductions in capital cost per kW are even more impressive.

How far the increase in size of unit will go depends on a number of factors but Sir Christopher Hinton has stated that for each doubling of capacity of a power station the total capital cost rises by only 80 per cent, while in addition there is a 2½ per cent annual reduction in costs arising from steady improvements in manufacturing technology. At present plans have not been finalised beyond 1964 but according to the annual report of the Central Electricity Generating Board the 1965 programme will include the first super critical generating unit of 375 MW and the first 500 MW unit on a single shaft.

Speed ring and spiral casing assembly of a 250 hp fixed propeller water turbine for the cooling system of the CEGB's Rugeley power station. An English Electric product.

These developments must inevitably exert a considerable influence on the structure of the electrical engineering industry. With annual additions to capacity of the order of 2,000 MW very few 500 MW units are required and even if the rate of installation of new capacity should be stepped up, the effect in terms of additional units is very small. A heavy burden of research and development work falls on the manufacturers concerned who must also instal new and larger machine tools and improved lifting cranes. This may necessitate the erecting of a new factory as has been done recently by Brown Boveri in Switzerland and it is clear that only a very limited number of companies will be able to justify the capital expenditure involved.

Considerations of this type were undoubtedly one of the factors behind the recent abortive proposals for the amalgamation of English Electric and GEC.

Long Term Research

The basic problem facing the electricity supply engineer is still the same as it always has been: the peak is always with us. Since large-scale storage of electricity by electrochemical means have not advanced significantly since the discovery almost exactly 100 years ago by Planté of the secondary battery, and the fuel cell is still in the experimental stage, the only means left is pumped storage: and 1961 will see

one of the largest pumped storage schemes in the world, the Ffestiniog scheme, being brought into commission, if not completed, and thus there will be the first really major contribution in Britain towards a solution of the peak load problem. This will be followed by a further station in the area of the South of Scotland Electricity Board in which a high level reservoir on the side of Ben Cruachan which will operate in conjunction with Loch Awe and a total capacity of 400 MW will ultimately be installed.

The efficiency of such stations is about 70 per cent and it is expected that the Ffestiniog station, in particular, will operate in close conjunction with the Trawsfynydd nuclear station, though not exclusively. If the pumped storage stations operate satisfactorily, and world experience shows that they should, then the outlook for at least some partial solution of the peak load problem becomes brighter. In a land like Great Britain where there are very few major hydroelectric possibilities, it might be thought water power had little future; but pumped storage projects do not rely on the topography of the land to anything like the same extent as normal hydroelectric schemes. There has been talk of establishing a pumped storage project on the coastline. Any area where there are cliffs of about 300 or 400 ft in height not too remote from fairly deep water, and where it is possible to conceive of flooding an area behind the cliffs, is potentially suitable for a pumped storage plant, entirely independent of normal hydroelectric considerations, and relying in no way on rainfall.

This is perhaps the first glimpse of a break through in finding a solution to the problem of better utilisation of the enormous capital investment in generating plant in a country such as Britain. About £300,000,000 a year now has to be invested in this field, and since the demand in a highly industrialised country like this has shown a tendency to increase at a greater level than the world rate of 7 per cent per annum (the figure announced by the Generating Board in 1960 was 9·8 per cent increase), then this capital investment figure must also increase, until it becomes, in perhaps ten or fifteen years' time, the largest single item of capital investment in the whole national budget. There is now, and always has been, a pressing need to improve the load factor beyond the figure of about 47 per cent.

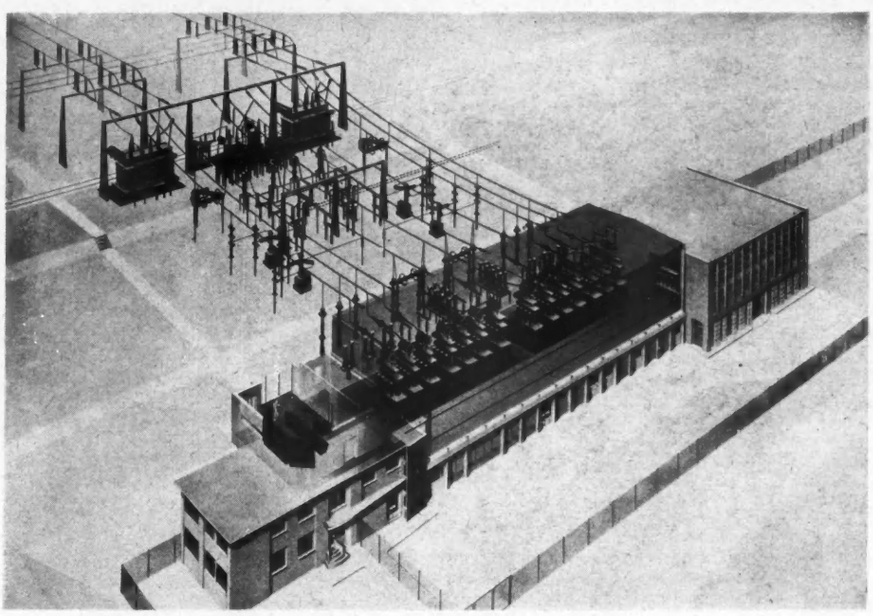
In the hydroelectric field 1961 will see work started in earnest on the Rance project for harnessing the tides. This has been made possible through the ingenuity of French engineers in designing streamlined totally-enclosed bulb-type pump turbine units with fully adjustable blades. The Rance project involves 24 generating units each of 10 MW, and these are installed in holes in a barrage across the river, where there is a very high rate of tidal rise and fall, up to 40 ft. The important feature of the bulb-type unit is that it can generate at low heads down to about 12 ft, but it can also perform three separate functions—generating, pumping or (with the blades fully feathered) valving. By borrowing the pumping energy from the network, the French engineers claim that this scheme can provide no less than 96·8 MW of energy at the peak period, whenever it may occur, in the winter months. This challenge is met by raising or lowering by pumping processes the water level inside the barrage, so that it is always artificially higher or lower than the level of the sea outside at the required time for generation.

The magnetohydrodynamic method of generating electricity directly from heat, developed in America, appears to be offering likely possibilities of commercial application: a 100 kW unit is under construction in the United States. This method, it may be recalled, hinges on the fact that an ionised gas is a conductor of electricity, and when it moves in a magnetic field an electromotive force can be set up, just as with a copper conductor. The ionised gas is made to flow through a powerful magnetic field and collector plates in the gas stream acquire a dc potential which can be inverted to produce three-phase ac for commercial application.

Direct generation can also be achieved by the use of radiation from nuclear sources acting through such devices as caesium cells, and up to 90 watts have been produced in this way.

All these methods are still, in general, in the laboratory stage, but there is a bright outlook for them, and nowadays development is getting swifter and within the next twelve months much more may be heard of all of these methods of superseding the conventional fuel cycle.

In electrical transmission affairs, 1961 has promise of two interesting developments. On the one hand there is need for increasing voltages to carry the larger amounts of power that each year require transmission from the large, centralised generating units to the centres of utilisation. In Britain, the 275 kV supergrid will have one section converted to 380 kV during 1961, and this will undoubtedly herald conversion of all parts of the supergrid to the higher voltage within the next few years. It is a tribute to the designers of the British supergrid that in 1950-51 they were able to announce that although insulators were not at that time available for 380 kV operation in Britain, with its highly polluted air in certain places, they were confident that their insulator progress would be such that within a few years this problem would be solved.



An impression of the converter station at the French end of the cross-Channel power link. By courtesy of Electricité de France and ASEA.

Therefore they designed the steel towers so as to be suitable for 380 kV working at a future date. This future date has now arrived. The outlook for transmission in the world as a whole is one in which higher voltages will appear within the next few years. In America a 460 kV line is to be brought into experimental commission, and the 750 kV experimental station will start operation at the end of 1961 or early in 1962.

In Russia, the 400 kV lines are being changed to 500 kV, and this will become the highest voltage in normal commercial operation in the world on an ac system.

Thus, in 1961, major steps towards a general rise in transmission voltages on ac systems will be taken; but for the alternative system of high voltage direct current power transmission, 1961 will mark an important step forward with the commissioning of the 160 MW, 200 kV cross-Channel cable connection, involving extremely complex engineering problems in regard to the actual laying of the "go" and "return" cables which must not be more than 10 ft apart to counter possible magnetic effects on ships' compasses.

Cables, whether for ac or dc, are likely to acquire some form of cooling, in the near future, to allow greater capacity for a given cable size.

The outlook for power transmission is bright; all developments on the generating side tend towards large units in few stations and this in turn means greater power transmission.

Forecast

Nothing said at the World Power Conference in 1960 pointed the way towards higher efficiencies than about 40 per cent, whether from supercritical or subcritical conventional steam generating plants. It is possible to see fairly clearly that the law of diminishing returns in increases in thermal efficiency is in operation and that the outlook must be thought of in terms of very small advances from now on; but when it is remembered that a 2,000 MW station will use 100,000 tons of coal a week, then there is every incentive to provide even 0·1 per cent improvement in overall efficiency.

The diesel engine, with its inherent size limitation, continues to hold its own, like the gas-turbine, for relatively small isolated plants; and its outlook is neither more nor less bright than it has been in the past. There are vast numbers of small urban communities in such countries as Australia, India and South Africa where the likelihood of interconnection with a major grid system, to take advantage of large-scale generation, is as remote as ever, and yet the load in those communities expands at the same rate as elsewhere, averaging 7 per cent per annum. Indeed, in some areas—Nigeria is one such example—electrical demand is expanding at an annual rate greater than 20 per cent, three times the world average. And so the diesel engine manufacturers can look forward to a steady demand for their products for application in stations of this type.

New methods of generating power appear to progress slowly. In regard to improvements to the conventional steam system, the Field advanced steam cycle is still under research by the Generating Board in England. Fuel cells are now under active development in several countries, and the most advanced is that developed by Bacon at Cambridge. The problems still to be solved relate to the increase of temperature and pressure at which the hydrogen and oxygen is supplied to the cell, while the use of fuels other than the pure gases still forms a difficult problem. Nevertheless, there is hope that high temperature cells will become commercially available within the next few years.

Data Processing and Business Equipment

Recording, reproducing, storing, handling, transmitting, converting and processing information.

THE second generation of computers will bring about a gradual transformation in business practice, causing repercussions throughout the office equipment industry. New organisational patterns will evolve, adapted to the needs of automatic data processing, and calling for more effective means of handling and communicating information—by machines ranging from typewriters and tape recorders to data coders and transmitters.

Design and Development

This year and next will mark a significant advance in the application of electronic data processing techniques, the effects of which are beginning to influence the design of conventional office machines and equipment and the traditional approach to automatic data processing. It is fitting, therefore, that this review of the developments in the field of information processing and business equipment should be concerned largely with those developments which are taking place in digital electronic computers and the equipment which is either directly associated with them or which stands on the fringe of these developments.

Over the past decade the manufacturers of office machines both in this country and in America have devoted a great deal of capital and effort to the development of commercial computers. This activity has resulted in a wide range of equipment the potential of which is only now beginning to be realised. The price range starts at under £20,000 for a small computer unit and extends to beyond £2,000,000 for a very large general purpose installation. Within the same price range the capabilities of computers are roughly equivalent, with more of one feature being obtained at the expense of another. It has been said that the pure economics of computer working tend to favour a large, fast machine, as it is estimated that the usefulness of a computer varies approximately as the cube of its price. It is doubtful, however, whether very much scope will exist in this country for the very large, fast installations with a cost exceeding £500,000.

In the development period, many of the problems in the commercial application of computers have revolved around the development of techniques and equipment which will provide information, input and output data, and give access to stored data at speeds which will support the speed of the central computing operation. Lack of the means of obtaining this, coupled with the complexity of programming and operating the computer itself, have given rise to much of the dissatisfaction with the original equipment. The result of ten years experience has now been incorporated in the "second generation" of computers which manufacturers are announcing.

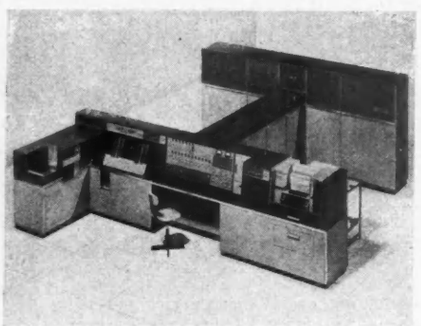
The technical advance which second-generation computers represent is indicated by the main characteristics that they possess, and these may be summarised as follows.

(1) Low cost: tending to find a level between £50,000 and £150,000 for a normal installation.
(2) Reliability: gained by producing "solid state" computers which incorporate transistors, printed circuits and magnetic core storage.
(3) Utilisation: improved utilisation as a result of a reduction in the time required for testing and maintenance and the reduced incidence of machine failure.
(4) Balance: designed as a comprehensive data processing system with input, output and processing units operating at speeds which are balanced to optimise the overall effectiveness of the installation.
(5) Simplicity: considerable simplification in the logical construction of the system, resulting in a new ease of programming and operation.
(6) Ease of installation: low power consumption, a reduction in weight and the elimination of heat have reduced the extent to which structural alterations are necessary.
(7) Flexibility: basic computer systems which are capable of accepting a multiplicity of ancillary units make it possible to start with a minimum of equipment and extend it as experience is gained and the need becomes apparent.

These new advantages mean that computers are now a sound, commercial proposition.

Second generation computers will be comprehensive data processing systems with input, output and other units balanced to optimise overall effectiveness; examples are the IBM 1400, the ICT 1301 and the National—Elliott 803: (Below) The ICT 1301 electronic data processing system, showing, on the left, output card punch; and from left to right in the main block: high-speed card reader, control console and high-speed output printer; in the rear are arithmetic and storage units.

(Right) Burroughs B251 Visual Record Computer



The tendency towards rapid technical obsolescence is one which is characteristic of the whole field of office machines. In the case of second-generation computers, however, it is most unlikely that they will become obsolete for the next ten years. The manufacturers need to consolidate their position and also to obtain some return on the considerable capital investment which they have made in the development period. Reference has already been made to the problem of developing high-speed input, output and data-storage facilities. Most of the technical advances in the future are likely to involve this peripheral equipment rather than the central computer system itself. A particular weakness in the United Kingdom is the inability to carry out high-speed printing, and it is expected that this need will be met in the near future.

The influence which computers are beginning to have on the design and development of conventional office machines and equipment largely results from the demands made by the ideal of fully integrated data processing. Application of the concept of integration has posed the practical problem of creating data at source and then communicating it to the computer. A great deal of the developments in conventional equipment have been aimed at satisfying this need, and will continue to revolve around the common language medium which computers have created.

The analysis of data recorded in punched cards is well established, and it was natural that the first medium for the input and output of information in a computer was the punched card. Although the need for greater internal speeds in computers has led to the development of magnetic tape and magnetic film, punched cards and punched paper tape are still the basic forms in which original data is created at source. Conventional machines are all being adapted to produce punched paper tape or punched cards as a byproduct of their normal visual recording operations. These developments will continue, as will also the development of equipment to convert tape to cards and cards to tape.

The two major applications of punched paper tape outside the communications field are the automatic recording of data for analysis or translation purposes, and the automatic control of a series of operations or processes. The information is coded by various combinations of holes punched in vertical channels across the width of the tape. The method of allocating these combinations to the basic description of information has been decided by international

agreement in the field of telegraphy and a 5 channel code is used, but there is at present no standard method of coding data for non-telegraphic purposes. Increased capacity and flexibility will tend to be sought in the data-processing field by the use of 6, 7 and 8 channel codes. Investigation into the adaptation of existing machines and the development of new equipment to use these expanded codes is already taking place, but the availability of this equipment will depend to a large extent on achieving unanimity on the code to be adopted. This matter is at present the subject of much controversy.

The use of paper tape and punched cards to control equipment performing a series of operations is now extending to the field of business information processing. Paper tape in particular is providing a basic compatibility between the whole range of equipment on which automatic as well as electronic data processing techniques are founded. Its use enables units of equipment with a variety of different characteristics to be operationally integrated.

Many of the developments in the field of data processing generally will revolve around the need to reduce the human element in selecting and recording data. Magnetic character recognition is well advanced, but not recognition of typescript. In the past year the development of optical reading equipment has progressed, and by using optical scanning methods it is now possible to read machine recorded data many times faster than with the human eye. In the next year or so machines of this type are expected to fill this gap in the processing of information.

Most electronic applications are concerned with handling data of one kind or another. Developments in communication and measuring

equipment, and in the whole range of conventional information processing and business equipment are tending to be dictated by the demands made on them by computers.

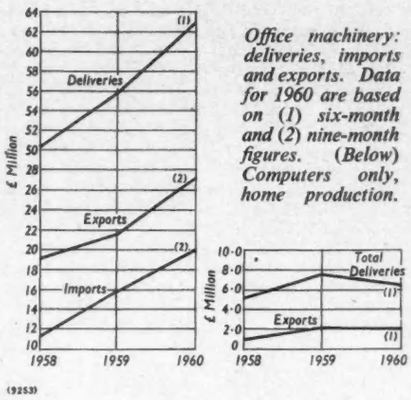
Future Events

The increased importance of information processing techniques and business equipment is reflected in the increase in the number of national exhibitions devoted to the subjects which will be held this year. A Second British Computer Exhibition will be held at Earls Court between 4 and 12 October. As with the first, in 1958, it is planned to coincide with the Second British Computer Symposium to be held also at Earls Court between the same dates. The 49th Business Efficiency Exhibition will be held at Earls Court between 2 and 11 October.

Evidence of the growing interest in computers can also be seen from a review of the number which have been or which it is estimated will be installed each year for commercial use. The increase from an average of 40 to 50 a year in the period 1957 to 1961, to an estimated 150 during 1962 marks the installation of second-generation computers, many of which have been ordered virtually " off the drawing board." This year will see a changeover in the ranges of most manufacturers from first to second generation.

In the past, attempts to apply scientific methods to assist in the solution of management problems have often been disappointing owing to the lack of a fast and flexible data-processing system. In practice, a compromise has had to be made between what is desirable and what is attainable. It is no coincidence, therefore, that the commercial application of computers is developing in parallel with the commercial application of advanced scientific and mathematical approaches to management such as operational research. This year will see a growing momentum in the acceptance by management of the practical value of these associated techniques and an increasing application of fully integrated data processing systems, which will incorporate the planned feedback which is characteristic of a well devised computer system. Probably the first function to reap the advantages of the new approach to data processing will be that of production control.

A new range of business machines will be delivered this year. This equipment is an attempt to bridge the gap between conventional machines and electronic computers, and to offer some of the speed and flexibility of electronic data processing at a price which is nearer to that of conventional machines. At the same time, machines of lower power consumption and smaller size and weight will be introduced. One of the first of these will be the IBM 3000, which is fully transistorised and takes up less space than three normal office desks. This machine, which is capable of carrying out all the functions of a full-scale punched card system, has already achieved a good sales record on the Continent. Punched card installations with electronic calculators have been available for some time now, but keyboard accounting machines with electronic calculation units are new. These new keyboard machines combine the speed and range of electronic computation with the traditional features offered in the past, and make it attractive to combine clerical routines involving calculation which are normally performed separately. As a byproduct of the visual record, these machines can also be used to produce punched paper tape for direct input into a computer or, by means of tape to card converters, to give punched cards for use with conventional punched card equipment.



Office machinery: deliveries, imports and exports. Data for 1960 are based on (1) six-month and (2) nine-month figures. (Below) Computers only, home production.

They can also be linked directly to a card punch so as to produce punched cards as a direct byproduct of the visual record. All of this equipment is very fast and very flexible by mechanical standards, but slow and extremely limited by electronic standards. Such machines will probably be best used to extend the possibilities of conventional machines and automatic data processing, and to provide the means of input for a computer.

Magnetic character recognition is being incorporated both in keyboard accounting machine systems and in the high-speed electronic document sorting equipment which becomes available this year. The advantages of having automatic character recognition and automatic recording of transactions were well appreciated by the bankers of America, and the practical use of magnetic character recognition has been pioneered there in conjunction with visual record machines. The London Clearing Banks have decided that British cheques should be imprinted with magnetic characters for sorting purposes, and British bankers recently saw a demonstration of an electronic cheque sorting machine. It is believed that one or two of the larger banks have also placed orders for keyboard accounting machine systems incorporating magnetic character recognition, to be delivered this year.

The need for flexibility is producing an expansion of the facilities offered with most standard equipment. Conventional machines such as electric typewriters, keyboard accounting machines, add-listing machines, mechanical addressing equipment and even cash registers are all being adapted to produce punched paper tape or punched cards as a byproduct of their normal visual recording operations. Punched card and paper tape operated typewriters are available, and the principle will be extended to other office machines this year. In machines of this type basic data and operating instructions are stored on punched cards, edge-punched cards or punched paper tape and are then used to achieve automatic recording by the machine of the coded information: the operation can be stopped where necessary so that variable information can be inserted manually by the operator.

As an example of the developments that are taking place, electric typewriters with punched card or punched tape operation and one or more paper tape output units can now be obtained, complete with one or more electronic adding registers as optional extras, and electronic calculating units will soon also be available as a further step in extending flexibility and integration.

Data processing equipment with magnetic character recognition: (Left) National Cash Register fully automatic Post-Tronic, comprising three units: punched-tape reader, Post-Tronic ledger posting machine, and automatic ledger feeder. (Below) De la Rue-Bull magnetic character sorter and reader. (Right) Detail of NCR electronic document sorter; cheques are automatically directed to one of 12 stackers.

External Factors

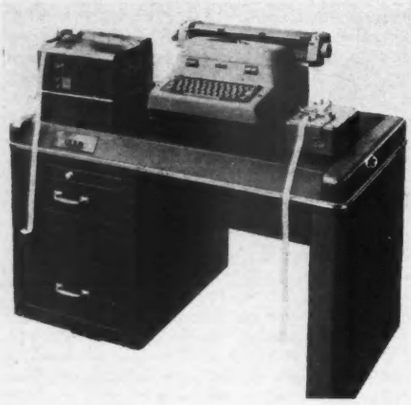
Apart from the technical development of the equipment itself and the effect that its growing complexity will have on staff and operational conditions, the main external factors continuing to influence the office machinery industry are rising clerical costs and the growing emphasis on forecasting and planning. Another factor at work since the war is the tendency for American companies to invest in new plant in this country and on the Continent to make office machinery. The attractions are partly the high cost of labour in the United States and partly ease of access to Commonwealth or Western European markets.

In 1960 the Institute of Office Management produced its two-yearly survey of clerical salaries. Over half the women approached used some kind of machine and, perhaps more significantly, the capacity to use a machine was reflected in the salaries paid to them. Taking the survey as a whole it appeared that office salaries, in Britain, increased since the last survey in 1958 by rather more than the rise in retail prices. The range of salary increases was between 7 and 12 per cent. In other words, the upward pressure of clerical costs on administrative overheads continues.

Market Trends

In 1958 the value of deliveries of office machines was just over £50 million. In 1959 it was just under £56 million and in the first half of 1960 the annual rate was about £62 million. The industry covers a wide range of products from computers at one end to metal furniture at the other. But over the whole range the machines which have recently received particular attention have been tape-recorders, dictating machines, electric typewriters and security devices such as locks and burglar alarms.

Computers apart, the indications are that the types of machines already mentioned are likely



Keyboard machine with tape output and tape control: Creed Creedomatic tape-punching and reading electric typewriter.

to be those most in demand in the immediate future both in the home and export markets. It is easy to see the influences which are at work. The high level of clerical costs is boosting the demand for reproduction machines of all kinds. This demand leads to either the substitution of copying machines for typewriters or a gradual switch-over to electric typewriters, which have, or should have, a higher rate of output than manual types. The interest in security machinery reflects the increase in organised robbery.

Exports of office machinery continue to be high. In the first nine months of 1960 they totalled just over £20 million compared with just over £15 million in the same period of 1959. Although typewriters have done well, there has been a slight decline in the exports of adding, listing and calculating machines.

Until comparatively recently the export position on computers was thought to be very satisfactory. At the end of November, however, a report called *Integrated Data Processing and Computers* (HMSO, price 10*s* 6*d*) was issued which had been prepared on behalf of the European Productivity Agency. This mission came to the conclusion that Britain is between 5 and 10 years behind the United States in the use and application of computers. Nevertheless this country has a developed computer industry which lies second after the United States.

The position on typewriters is particularly interesting for UK exports have been good while imports have been buoyant. By the end of 1959 imports of typewriters actually exceeded exports and this fierce foreign competition continued through 1960. In the first nine months of 1960 typewriter imports were still running slightly ahead of exports. All typewriter manufacturers in this country are subsidiaries of foreign companies except the Imperial Typewriter Company Limited, which is the second largest manufacturer in the UK, and its very much improved performance of recent years has been based on the home market. It may, however, make further progress in the next few years in export markets, particularly with the development of its typewriters to use non-Roman characters. An outstanding threat in the UK market is British Olivetti, which has not made as much progress in Britain as it has in its other foreign markets.

The prospect overall is for more typewriters to be sold both in home and export markets and, so far as the UK is concerned, a continuing battle between importers and firms established in the UK selling in their own domestic market. Price cutting developed in world markets in 1960 and may go further in the current year. On the other hand the decision not to allow a tariff to protect the United States typewriter industry will continue to keep that market open for European models.

The formation of the European Free Trade Association is affecting the expansion policy of certain well known companies. Machines Bull, the largest French manufacturer of calculating machines, has made an agreement with AB Hadar Schmidt of Sweden under which the two companies are to create a joint marketing organisation to be called Svenska Bull AB which will sell Bull electronic equipment in Sweden. Machines Bull are already in association with the de la Rue Company. The expansion of the French company into Scandinavia is one of the first attempts by French industry to break out of the European Common Market into the European Free Trade Association. Meanwhile, International Computers and Tabulators Limited has made an arrangement with the West German Siemag group by which Siemag Fein-Mechanische Werke GmbH will manufacture ICT punched-card and electronic equipment. This move is aimed not so much at the German market as at the ECM as a whole. Meanwhile the IBM World Trade Corporation has opened a new IBM centre in Amsterdam where it is proposed to concentrate production for a systematic attack on the European market and the EFTA. IBM have also set up a new centre in Berlin.

Management and Labour

In an industry employing between 45,000 and 50,000 persons in this country the main problem is to find highly trained engineers and sufficient skilled and semi-skilled operatives to develop its new machines in an era of full employment. So far as operatives are concerned, over the last decade the industry has found the answer by going to a large extent to the so-called development areas, such as Clydeside, Tyneside and South Wales.

Keyboard machine with electronic calculator: Burroughs Sensimatic with electronic calculator for tape or card output.

The biggest problem, however, at the present time, and one that is likely to continue into the future, is the shortage of engineers and technicians. Although the demands by the computer industry on the supply of engineers are not very big, it requires recruits from a fairly wide cross-section. There is a need for first-class engineering ability in research and development work. Increasing numbers of programmers are also required. These have studied operators' particular requirements and prepare the programme which is fed into the computer. There is then the maintenance engineer who is needed to keep the machine running. So far as research and development work is concerned, the industry is competing acutely for a limited quantity of first-rate personnel. So far as the programme is concerned, the need is to obtain sufficient recruits to enable the industry to break new ground in the application of its machines. Supplies of maintenance engineers are not easy to come by but they are more readily available than the other two.

Because of the shortage of all three types of personnel, there is a tendency for comparatively unqualified youngsters to be taken on as maintenance men and upgraded through the system at least to the position of programmers doing a certain amount of original work. The conditions of the market are such that unqualified men are bound to be given increasingly responsible jobs and the profession will have to bear in mind that as the computer field opens up in this country its connections with professional engineering bodies will need to be reinforced. The problem is a growing one: there are going to be more computers of an increasingly complex type. Although complexity may mean ease of operation, design will require intellectual quality of the highest order.

Plant and Material Supplies

The office machinery industry is as constantly and fully aware that it is an assembly industry as, say, motor vehicles.

The supply problem for the industry must always concern steel availability, import duties and quota arrangements. In the foreseeable future, steel is not likely to be a big problem. The European steel industry has given expansion of sheet steel capacity a high priority since the war, and at present the recession in the car industry has made the steel industry all the more anxious to sell to other users of sheet.

Tariffs are a rather more complicated problem. The trend in general is for tariffs to decline but there is one major complication. This is the splitting of western Europe into the European Common Market and the European Free Trade Association. Big plans for setting up factories in Europe to make a range of standard components in each area for assemblies to be sold in the western European market as a whole, could be seriously impeded by the ECM and EFTA split. To date, however, division of labour to make standard components is mainly on a national scale only, and import restrictions for a more ambitious international division of labour are a threat only for the future.

Production

The Business Efficiency Exhibition at Olympia in 1960 emphasised, among other things, the application of office machinery to small organisations. At the same time the popularity of "wired" machines appears to be growing.

This kind of equipment, which comprises standard accounting machinery lined-up with paper tape or punched cards has been popular in America for several years. It is only just beginning to break into the UK market, however. Where a central office wants regular data from its branches the paper tape information can be put through to head office by teleprinter.

The teleprinter is indeed beginning to find new uses. Some companies are beginning to use it for production control systems. It has been found that a teleprinter is quick, accurate and provides a written record which can serve as an authorisation for immediate action; it cuts out conversational wasted time on the telephone; it offers major economies where there is a good deal of routine communication; it can be used with punch cards and hence integrated with advanced data processing machines; and it can be linked with the international Telex network and can thus deal promptly with export matters. Using this system, production control can be exercised by transmitting orders

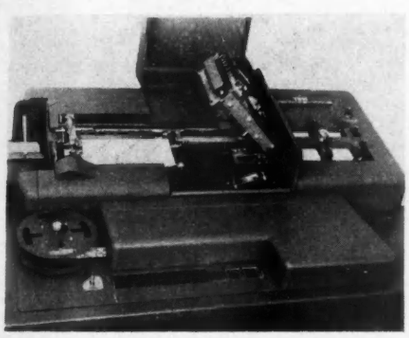
Electronic reading machine: (Right) Solartron Electronic Reading Automaton, showing console; the tally roll on the right has been read.

rapidly to factory or warehouse, and often time can be saved by multicopy preprinted stationery to provide records for accounts and sales departments. One of the outstanding examples of such control is the Ford plant at Dagenham.

Up until the middle of 1960 it was estimated that about 368 electronic computers had been made by British companies and delivered here and abroad. At least 117 more were known to be on order. Exports at that time were estimated to account for about 20 per cent of total deliveries.

The industry is in a difficult position. It is repeatedly told that its biggest danger is that customers will rush into computers because they are fashionable, live to regret it, and tell other potential customers about their unfortunate experience—which would probably be blamed on the computer or its manufacturer. The substitution of transistors for valves in the latest machines offers more complex machines with fewer maintenance problems. It is also true that manufacturers are increasingly prepared to offer smaller machines which will do less elegant and intricate calculation. On the other hand, potential users are repeatedly told that it is uneconomic to use computers for only one major job, such as stock control or wages.

On top of this, the EPA report already referred to has offered a fairly severe criticism of the industry. Sir Walter Puckey said at a press conference when the report was issued that organisations had failed in the United Kingdom to put over to managers the importance of data processing and control by means of computers. He thought that further mergers of manufacturers might be expected. He himself is a director of International Computers and



Conversion plus transmission equipment: (Above) IBM163 card-to-tape converter. (Right) ICT tape-to-card punch.

Tabulators Limited, which was the outcome of an amalgamation between the British Tabulating Machine Company and Powers-Samas in the punch-card field. It may be that only by some streamlining of this sort can the necessary expertise and financial resources be assembled to provide the pre-installation survey work, a high standard of work in the actual installation, and adequate post-installation servicing of the equipment. It is said that the computer market in the United States is worth about £100 million a year while that in this country is worth about £5 million. Figures of this kind are exceedingly difficult to check but if even the dimension is correct it would seem that there are more computer manufacturers in this country than the market can reasonably sustain in the foreseeable future. The two advantages which the American market seems to have over the British market are, first, that the market itself is very much bigger. Second, the high level of salaries in the United States means that a computer can justify itself financially very much more quickly.

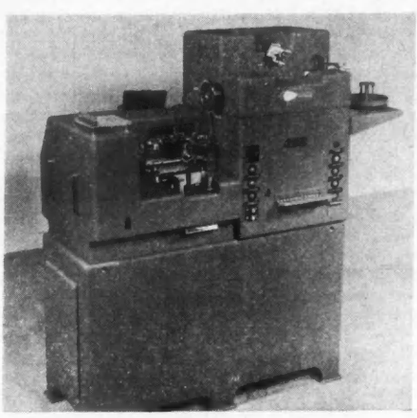
Expansion and Investment

It is not likely that there will be any spectacular increases in capacity in the office machinery industry in the next year or so. In some well known sections such as computers and typewriters there is already plenty of capacity for available demand. In other directions where there is a notable increase in current demand—such as photocopying equipment, duplicators and dictating machines—it is possible to introduce new models with significant improvements in styling and performance by changing production lines. There are likely to be isolated cases of expansion of capacity but net increases in the capacity of factories in this country are not likely to be very large. The resources of companies—and here it becomes important that so many concerns in the UK are subsidiaries of US companies—are likely to be earmarked to some extent for developing expansion in continental Europe. This tendency is already apparent in the exchange of licensing arrangements and mutual selling agreements for non-competing lines. In most types of office machinery, competition is now exceedingly acute and only those producers with considerable experience and large resources are likely to be successful in new fields. Reference has already been made to the possibility of amalgamations in the computer business both in this country and the United States. This trend is not likely to be limited to computers. The merger between the Sperry Corporation and Remington Rand in the United States to create Sperry-Rand involves other products besides computers, and this particular amalgamation has, for example, resulted in the acquisition of another American company, the Clary Corporation (which made adding machines and cash registers), and the termination of an agreement with a French company.

Long Term Research

What is the pattern of future development in information processing and business equipment? As has already been indicated, this future is inevitably linked to the future of electronics and the practical application of the concepts of automatic and integrated data processing.

Electronic and automatic data processing generally involves some degree of centralisation and the overall efficiency of the systems will depend to a large extent upon the speed and the form of data transmission, particularly in large or decentralised organisations. Reference has already been made to the need to develop means of communication which can provide information at a speed and in a form which can support the new principles of data processing. The provision of data and the dissemination of



results still present a practical problem. The concept of teleprocessing is probably as important to the field of data processing as the advent of digital electronic computers. It is only being realistic to say, however, that the developments in this country in the telecommunication field have lagged well behind the developments in data processing. This area presents possibly the greatest gap at present in the broad pattern of information processing. Measures will be taken to close this gap over the next ten years.

Claims have been made that machines have been developed which can recognise handwritten script. It is very doubtful, however, that equipment will be produced in the current decade which can recognise manual scripts with all their lack of uniformity. A forecast was recently made in America, that equipment would be available in 20 years time that would automatically translate spoken words into a foreign language and also reproduce spoken words directly in a documentary form.

The next ten years will see the problem of organising around a computer eased in many ways. The development of automatic coding techniques will continue and communication with the computer will become more easily understood. Computers will be used to programme their own operations and to analyse the problems which they will have to solve.

The system will be able to read directly any script recognisable by human beings, or even to appreciate human speech. The scope of application will grow until every aspect of an organisation will be planned around the most effective use of a computer. Once the computer has become powerful enough we may expect a new logical approach in areas which are at present not susceptible to analysis.

Forecast

The new concepts of automatic data processing and teleprocessing evolved to serve and assist the commercial application of computers are almost as great a revolution as the concept of electronic data processing itself. The physical changes in equipment design are only just appearing on the scene, but the characteristics which the new machines possess will be developed and extended to cover the whole range of conventional information processing equipment and business machines. The equipment is now available to achieve many benefits, but the main factors which will prevent organisations from taking advantage of them will be the lack of experienced personnel, the lack of an organisation and formal communications system which will support the speed of data processing, and the lack of a management which appreciates the potential which is offered.

Thus in the immediate future there will be greater emphasis on the communication, data-conversion and facsimile-reproduction aspects of business operations. Equipment for transmitting information between the organs of an industrial concern, input-output systems, coding, and the humbler aids of automatic typewriting, tape recording, duplicating and photocopying are fields in which the main activity is likely to be concentrated.

Equipment will be designed increasingly for unskilled operation, and conversely, unqualified men will be given training to fit them for limited technical responsibility—at least in the next few years. Organisation of industrial and commercial business will continuously be adapted to meet the requirements of automatic and integrated data processing, with operational research playing a growing part in guiding management decisions.

New markets, presumably in Europe, will be sought to justify the necessary scale of manufacture. For the same reason a proselytising attitude towards potential customers is likely to be adopted in this country. Further attempts will be made to cheapen the general-purpose computer, which in the long run is likely to prove more economic than computers designed for special tasks. Later the survival potential of second-generation computers will permit a degree of consolidation in the industry.

What then is the outlook for information processing and business equipment? In the application of electronic digital computers and the new concepts of electronic, automatic and integrated data processing which they have generated lie the immediate potential to revolutionise all the accepted ideas of organisation, management and control. In America and in Europe the need for change has been accepted more readily than in this country. In the United Kingdom we shall succeed or fail in this new era largely by the speed with which we can adapt ourselves to and exploit the new forces which are becoming available.

Vehicle and Transport Manufacture

Locomotives and rolling stock, cars, vans and lorries, automatic transmissions, marine propulsion, ships, aircraft, ground-effect machines.

THE operation of each of the four main branches of transport—sea, rail, road and air—is sometimes complementary to one or more of the others and sometimes in direct competition. Apparent monopolies in the performance of particular transport tasks can be outmoded very quickly by technical developments, as illustrated by the recent phenomenal growth in trans-atlantic passenger and cross-channel accompanied-car traffic by air to the detriment of the growth of established surface facilities. In a similar way, the present position of the ocean-going oil and ore carrier might be challenged by current developments of vehicles such as the Hovercraft and nuclear-powered submarine, or that of road and rail tankers by more economic methods of production and laying of pipelines and improved pumping techniques.

Design and Development

The prospects of British manufacturers of transport equipment for 1961, insofar as they are affected by engineering design, are generally promising, with shipbuilding the least healthy and the motor industry as a whole likely to remain the most profitable. The outlook for the aircraft industry remains good in the short term, particularly as far as engines and auxiliary components and services are concerned, but less certain in the long term until the effects of the recent regrouping have been assessed. Manufacturers of railway requirements, particularly of signalling equipment, trackwork, wheels and axles, the smaller types of power units and so on, should continue to find profitable outlets, while the position of locomotive builders will have been eased as far as competition in world markets is concerned by the creation of a substantial home market for diesel and electric locomotives by the advance of British Railways re-equipment.

The remarkable success of the small front-wheel drive BMC cars and vans might well stimulate other manufacturers into renewed experimentation with space-saving engine positioning and new forms of suspension in future designs, some of which are promised in 1961. Otherwise there are unlikely to be general major design changes.

A significant event in the heavy goods vehicle field is the entry into service of the frameless light-alloy road tanker built for the British Petroleum Company by Thompson Brothers (Bilston) and Leyland Motors. The advantages of reduced tare, lower overall height and lower centre of gravity possible with integral (chassisless) construction have already been widely exploited in bus construction and to a lesser extent in semi-trailer tanks and vans; although impracticable for general-purpose goods vehicles (except car-derived light vans) because of the wide variety in type and purpose of goods bodywork, the technique promises substantial improvements in operating efficiency of bulk haulage tankers, use of which is increasing rapidly not only for liquids but also for powders, grains and pellets.

No small part of the remarkable postwar expansion of British commercial vehicle exports is owed to the incomparable reliability, durability and fuel economy of the automotive diesel engine. But unrealistic limits in the United Kingdom on speeds of commercial vehicles have encouraged the use of engines of comparatively low power. Fortunately, growing use of the new motorways, where there are no speed limits, has accelerated what was a rather slow redress of this deficiency and several of the 1961 ranges of heavy vehicles have diesel engines of substantially higher power, improving their competitive position in many overseas markets.

A profitable development made possible by the availability of engines in the 250 to 400 hp range and matching transmissions and other units, is an entry into the world market for very large specialised vehicles for oilfield, earth-moving and construction work, which for many years has been dominated by American manufacturers. Roundly half a dozen British heavy-vehicle builders now compete in this field. The conventional layshaft gearbox, with auxiliary reducing trains, is now quite outmoded as far as this class of vehicle is concerned, its place having been taken by hydraulic or hydro-mechanical transmission, of which there are now several British examples for torque inputs of up to 1,000 lb-ft.

The overall efficiency of hydrokinetic systems, however sophisticated, is not high judged by mechanical transmission standards (though the loss is offset somewhat by gains in other directions) and competition from other types of transmission is developing. The first challenge is likely to come from hydrostatic systems, examples of which have already been brought to the production stage for up to 80 hp by Dowty and up to 125 hp by Lucas.

Another major road vehicle system that has changed little since it was first applied (according to Pepys) to a road carriage by Colonel Blunt in 1665—the steel plate or leaf spring—is at last under strong pressure. After a number of false starts, in Britain as elsewhere, pneumatic suspension has apparently emerged from its gestation period to pass into wider usage on certain classes of commercial vehicle, while solid rubber and steel coil springs are well established in several makes of road vehicle from light cars up to buses and the bogies of very heavy vehicles.

Other road vehicle systems in process of change are tyres and some electrical components. The trends towards higher loads in commercial vehicles and higher speeds of all types of vehicle have necessitated the development of tyres and tyre materials of superior performance, notably high strength rayon, nylon and radial steel cords and improved rubber blends.

Engineering development in the marine field, with its basic practices long established and vessels built for service lives of 30 years and upwards, is inevitably slower paced than in aeronautical or road vehicle engineering. Trends in the bulk carrier field are generally towards larger vessels and higher operating speeds, as exemplified in recent oil tanker construction, and the substitution of diesel machinery for steam turbines in higher tonnage classes. The combination of diesel-engine efficiency with the convenience of turbine drive in the free-piston gasifier and non-combustion gas-turbine is now highly developed. Extension of application of the system in cargo vessels of up to medium tonnage can be anticipated, as much for its applicational flexibility, which can obviate the need for a large engine room breaking up mid-ships space, as for its efficiency.

Most spectacular of the recent developments in marine propulsion is the use of a nuclear reactor to provide heat for steam generation. First applications in America and in Britain are to submarines in which high initial cost and comparatively low conversion efficiency can be tolerated in the cause of the military value of unprecedented cruising range and independence of bases or depot ships. Although experience gained in the operation of these naval craft might provide a basis for judging whether nuclear propulsion is ever likely to become an economic proposition for commercial vessels, some years are likely to elapse before a useful evaluation is possible.

First application in a big ship of the Vickers-Armstrongs transverse-propulsion system made news recently, when the new P & O-Orient liner, Oriana entered service. Electrically powered, axial-flow impellers in forward and aft transverse tubes in the hull (see diagram, p. 125), the units are directly controlled from the bridge and provide instantaneous sideways thrust to counter any unwanted rotation of the vessel.

Major engineering trends in rail transport concern the continuing replacement of steam by electric and diesel locomotives; the extension of the use of powered coaches in multiple-unit passenger trains for suburban and even for some longer distance services; the through-braking of goods stock to provide much faster goods-train schedules and less interference with passenger services; and the simplification of track layout, rationalisation of signalling and concentration of wagon handling in large mechanised marshalling yards.

The main emphasis in the electrification programme has been on the conversion to 50-cycle ac with overhead supply for main lines and also for suburban lines where dc electrification was not already in extensive use, for example, in the Southern Region, which retains dc third-rail supply. In the new main-line locomotives, the already well-established designs incorporating dc traction and control equipment have largely been retained, conversion of the high-voltage ac supply having called for development of efficient lightweight locomotive-mounted rectifiers and improved designs of lightweight overhead current-collection equipment. Restricted clearances on some sections of line have necessitated dropping voltage from the standard 25 kV supply to 6·6 kV on these sections, and successful voltage-change sensers and automatic changeover equipment for uninterrupted running through such sections have been evolved. Progress in the immediate future is perhaps more probable in rectification equipment—in the further development of germanium or other semi-conductors, for example, in the elimination of moving parts in control gear and in pantograph design than in basic components.

Electrification extensions have brought problems in providing efficient through services over non-electrified sections and in cases have necessitated provision of an excessive number of independently powered locomotives for service on non-electrified tracks and sidings. These have resulted in the development of dual-purpose electro-diesel locomotives, the first of which will soon be entering service on the Southern Region. Straight electric equipment operated from the

3,300 hp electric locomotive for British Railways.

Vickers VC 10 with rear mounted Conway engines.

third rail forms the basis of the design with a medium-power diesel engine-generator to provide power on non-electrified sections or where current is switched off for maintenance or other purposes.

Electric and diesel-electric multiple-unit trains have a common area in which early development is likely, that is, in the provision of electric braking. The principles of rheostatic and regenerative braking are already highly developed and various systems have been quite extensively applied to railway rolling stock including locomotives.

In general construction methods and materials, the railways have been rather slow to adopt new ideas, but much has been done in the recent past to make up lost ground. The immediate future is likely to see great progress in the development of more economical construction techniques for all types of rolling stock as the cost of new materials and processes is brought down to an economic level. There has already been an extensive switch to the use of plastics in decor, furnishings and non-stressed secondary structures.

Engineering developments in civil aviation are essentially long term and consequently much of the current design effort is bent towards the evolution of an acceptable supersonic airliner by about the end of the present decade, with, if possible, the added ability to take off and land vertically or nearly vertically. Nonetheless, there are many developments of more immediate significance to the airlines. One of these is the entry into widespread service with British European Airways and Trans-Canada Air Lines of the Vickers Vanguard, which, with its second-generation Rolls-Royce turboprop engines giving a cruising speed of 420 mph and remarkably low operating costs and its "double-bubble" construction conferring unique passenger-freight versatility, might well confirm the place of the turboprop in short to medium-stage operation for many years ahead, despite the economy which is promised by the high-bypass-ratio turbojet.

The place of the turboprop in short-stage passenger operation is already secure and both the Handley Page Herald and Avro 748 are shortly to enter service in this field, while the Dart-powered Armstrong Whitworth Argosy freighter—the first aircraft to offer full-width loading doors at both ends of a capacious fuselage—appears set to reap the just reward of thoughtful design.

Representing about the ultimate in subsonic turbojet transport design, the clean-wing (aft-engine) de Havilland Trident ordered for BEA and the Vickers VC10 ordered for BOAC are both due to fly this year; the aft-engine concept, pioneered by Sud-Aviation in the Caravelle, later marks of which will probably be built by Douglas in America, has also been adopted by Boeing for its short to medium-range 727.

The rapid introduction of jet aircraft on trunk passenger routes has resulted in many modern piston-engined transports being offered for sale at low prices. Some are being bought and converted to freighters, which should result in a massive expansion of air-freight business, but whether these converted aircraft will be able to compete effectively against the superior economics of such aircraft as the Argosy and swing-tail Canadair CL44 and Short Britannic, all powered by turboprops, remains to be seen.

An early return to scheduled helicopter operations by BEA is being made possible by the imminent availability of more economic larger types of machine, such as the Vertol V107, Sikorsky S61 and Westland (Bristol) 192. Further progress with gas turbines for helicopters and in design of the twin rotors necessary for safety in passenger operation is likely to produce aircraft more acceptable to airlines, and also to people living or working in the vicinity of heliports, and possibly capable of profitable operation. The twin Napier Gazelle-powered Westland 192C, for example, with a passenger capacity of 15, possibly BEA's choice for reopening limited Government-subsidised services during 1961, will quite soon be superseded by the Westland 194, a quieter 50-seat development.

Aero engines are currently being developed along two broad lines to produce the most economical cruise required for high payload-range capacity and to develop the greatest specific thrust for providing ability to take off and land vertically. A combination of the two objectives is seen in the Bristol BS53 rotatable-thrust engine, which is a high-ratio ducted-fan turbo-jet of high propulsive efficiency (and consequently low specific fuel consumption) and is fitted with rotatable nozzles to provide thrust capable of lifting the aircraft vertically off the ground. Already proved for vertical lift in the Hawker P1127 single-engined aircraft, in which transitional flight trials are about to begin, the BS53 might well prove a more economic proposition in transport aircraft than separate lift engines and a more practical one than the tilt-wing concept. A competitive system for providing aircraft vertical or short take off and landing capability, using the ground-effect principle of hovercraft, is under development on a short-term government contract in America by the Vertol division of Boeing and possibly also in a private capacity by Hawker Siddeley in Britain in its GERM programme.

Future Events

Among events due to take place in 1961 are a number certain to affect the various elements of the transport industry. Road operations in Britain will benefit considerably from the various road schemes, two of which—the Hammersmith Flyover and a further section of the Birmingham-Bristol Motorway—are due for completion in late summer or autumn. Award of the contract for further sections of the Birmingham-Preston Motorway and the Minister of Transport's invitation of definite proposals for the £2·9 million east-west Blackfriars Underpass bring these schemes a stage nearer to the point when they will make a useful contribution to the country's trunk road network.

Significant 1961 events in the marine world include the launch of the American hydrofoil gas-turbine ship, which is expected to produce much new data on the economic potential of this form of craft and the various developments of the basic Hovercraft design, some of which are due to "fly" during the year. One of these is the SR-N2, under construction by the Saunders-Roe division of Westland Aircraft, a 25 ton craft powered by four small gas turbines to carry up to 68 passengers at speeds around 70 knots. Other firm designs, though not so far advanced, are the GERM projects of the Hawker Siddeley Folland company for 30 knot 5 ton capacity Hovertrucks having ability to operate over water, marsh and rough bulldozed tracks and still larger vehicles of 150 passenger or 20 tons capacity to cruise at 80 knots.

Railway engineers can be expected to watch with interest the operation of the Altweg elevated monorail system now under construction in Turin and scheduled to provide the first Altweg public transport service with two trains when the Turin Exhibition opens on 1 May. Initially of 1·2 km length to serve the exhibition, extension to 11 km is planned to connect Turin centre with the suburb of Moncalieri, while it is reported that the Japanese plan to construct a 15 mile Altweg system between Tokio centre and its airport.

Some of the major aeronautical events of 1961 have already been referred to. In addition, a much clearer indication of the feasibility of supersonic transports should emerge as a result of experience with the British Aircraft Corporation's T188 mach 2-plus research machine, due to make its first flight during the year, and the small Government contract awarded for a supersonic airliner design study.

External Factors

At the end of 1960 the industries producing vehicles and transport equipment were all faced with declining demand which will probably continue during the current year. Manufacturers of motor vehicles hope that the recession will be short lived though they are likely to have some difficulty in making good the fall in exports to the USA resulting mainly from the success of the US compact cars. Manufacturers of locomotives and rolling stock are becoming increasingly apprehensive of the future once the main demand arising from the railway modernisation programme has been met, particularly since there has already been a marked fall in export demand. While shipbuilders still have nominally some two years work in hand new orders are running at a very low level and as a result of the marked expansion of shipbuilding capacity abroad very severe competition is to be expected when demand again starts to rise. Aircraft manufacturers have continued to maintain a high level of exports and new orders received during the past year were higher than at one time expected.

Market Trends

With deliveries of diesel and diesel-electric locomotives to the British Transport Commission now reaching a peak, locomotive builders have been very busy during the past year and are likely to continue so for a further two or three years. The total number of diesel locomotives added to stock by the Commission rose from 195 in 1957 to 400 in 1958, 601 in 1959 and an annual rate of 710 in the first half of 1960. Moreover, an increasing proportion of this total in recent years has consisted of main line as opposed to shunting locomotives. By the middle of 1960 the BTC had placed orders for 1,827 main line diesel locomotives of which 547 were already in service.

Exports of locomotives, however, have been disappointing. After a fall from 504 valued at £10 million in 1958 to 446 valued at £9·3 million in 1959, there was a further decline to an annual rate of 389 valued at £7·3 million in 1960. This development is particularly serious since the home demand must be expected to fall off very substantially after 1963 and unless exports can be built up by then, the private locomotive builders will be faced with a high proportion of surplus capacity. On the basis of numbers, exports of diesel and diesel-electric locomotives in the first half of 1960 represented just under one-quarter of production. (See graph next page.)

Manufacturers of rolling stock have already been seriously affected by the virtual cessation of orders for wagons from the BTC. From a total of 61,479 in 1956 the number of wagons added to operating stock by the BTC fell steadily to 16,242 in 1959 and an annual rate of 5,800 in the first six months of 1960. Exports have also fallen from 5,886 in 1957 to 4,971 in 1959 and an annual rate of 1,700 in the first half of 1960.

Coach builders have been less seriously affected, the number added to operating stock by the BTC falling from 2,567 in 1958 to 2,419 in 1959 but rising again to an annual rate of 3,600 in the first half of 1960. Coachbuilders have recently received substantial orders for tube cars to complete the replacement of rolling stock on the Central and Piccadilly lines.

The statistics for the production of aircraft given in the table show a marked fall for the first nine months of 1960. These statistics, however, are not a very good indication of the

state of activity in this industry since they exclude aircraft of military type except those produced for export. In so far as the future of the industry lies with civil aircraft, however, they provide a measure of the problems facing the industry. In export markets, which account for a high proportion of total production, the industry continued to do well during the past year, though total exports of aircraft and engines in the first nine months of 1960 were running at an annual rate below those for 1958 and 1959. The decline was confined to complete aircraft and exports of engines continued to expand.

During the first half of 1960 the industry obtained substantial new orders, totalling 43 aircraft valued at about £53 million of which over half were for export, but there was considerable anxiety regarding the future trend of exports. After the intensive buying of jets in recent years it was felt that the airlines' resources for the purchase of further aircraft had been substantially reduced while the number of different types of aircraft available for purchase was probably greater than ever before.

For the first nine months of 1960 the motor vehicle industry presented a picture of unparalleled prosperity and even allowing for the cut-back in production towards the end of the year, total output and exports for 1960 are likely to have constituted a record. Nevertheless, by the end of the year the industry was suffering from substantial overproduction and short time working was widespread.

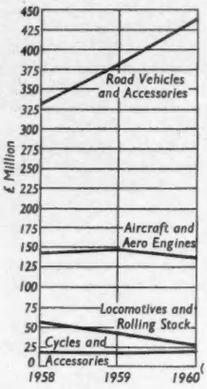
The production of private cars for the home market rose from 33,260 per month in 1957 to 44,100 in 1958, 48,300 in 1959 and 69,800 in the first nine months of 1960. Over the same period production for export rose from 38,500 to 43,500, 50,900 and 53,500 respectively. While the export record was impressive, therefore, the unprecedented boom in the early months of 1960 owed more to expansion of home sales than of exports. Up to September, 1960, the weekly rate of production continued to run above the level of 1959 but with exports falling in October to 24,279 cars and stocks increasing in dealers' hands, the leading producers were forced to reduce production to a level of probably about 17,000 per week by the end of November.

This situation confronts both the industry and the Government with serious problems. The industry argues that the recession on the home market is largely due to the tightening of the hire putchase regulations, but it goes even further than this and argues that if prices are not to be increased as a result of the cut back in production, home demand must be stimulated both by the removal of the latest hire purchase restrictions and by a cut in the level of purchase tax. In the annual report of the British Motor Corporation Sir Leonard Lord said that the corporation has been absorbing increased costs by raising output since the last price rise in 1957 but if output has now to be reduced this formula will no longer work. The Government on the other hand is reluctant to give the green light to an expansion in home demand which may further worsen the country's balance of payments and reduce the incentive to export.

United Kingdom Production of Transport Equipment

	1958	1959	1960
Locomotives (electric and diesel electric: No.)	853	1,054	1,170[1]
Railway coaching vehicles (No.)	3,051	2,649	3,704[1]
Wagons (No.)	42,225	21,213	7,530[1]
Aircraft[2]—			
Piston engine (No.)	144	79	49[3]
(Index of Airframe structure Weight (1954=100))	36	13	9[3]
Turbine engine (No.)	336	281	109[3]
(Index of Airframe structure Weight (1954=100))	442	309	174[3]
Passenger cars ('000)	1,052	1,190	1,350[4]
Commercial vehicles ('000)	313	370	452[4]
Motor cycles, scooters, mopeds and three-wheeled motor vehicles ('000)	140	249	238[3]
Pedal cycles ('000)	2,160	2,208	2,220[3]
Powered Industrial trucks (No.)			
Fork lift	3,576	3,996	4,917[5]
Other	2,640	2,520	3,710[5]
Merchant ships over 100 gross tons completed ('000 gross tons)	1,441	1,381	1,296[4]

[1] Based on first six months.
[2] Excluding military aircraft except those produced for export.
[3] Based on first eight months.
[4] Based on first nine months.
[5] Based on first seven months.



(9263)

Exports of transport vehicles and equipment from the UK in £ millions.

(1) Based on first nine months.

The case for some relaxation of home market control would be much stronger if the ratio of exports to total production had been expanding instead of falling. Over the period of most rapid expansion of production, i.e. between 1957 and the early part of 1960, this ratio fell from 53·5 per cent to 43 per cent. Of the increase in exports over this period a large part has been due to an expansion in exports to North America and in 1959 Canada and the USA accounted for 55 per cent by value of total exports. With the success of the US compact cars it will be extremely difficult to maintain, let alone expand, exports to North America.

The British shipbuilding industry has for some time been living mainly on orders accumulated some years ago. During 1960, however, merchant ships of over 100 gross tons completed fell from 1,441,000 gross registered tons in 1958 to 1,381,000 tons in 1959 and an annual rate of 1,296,000 tons in the first three quarters of 1960. The decline in tonnage laid down was more pronounced from 1,273,000 tons in 1958 to 1,137,000 tons in 1959 and 932,000 tons in 1960 with the result that tonnage under construction fell from over 2,100,000 tons at the beginning of 1958 to 1,650,000 tons at the end of the third quarter of 1960.

New orders received in the first nine months of 1960 totalled 176 ships of 417,000 tons, equivalent to an annual rate of 556,000 tons. The industry's total order book at the end of 1960 was said to amount to about 3·5 million tons, of which over half comprises tankers. Some of these orders may, however, be subject to cancellation or postponement by the shipowners concerned.

The fall in activity is not confined to UK shipyards. At present there appears little prospect of an immediate revival in orders and these figures suggest that even when such a revival takes place there will be very severe competition for the available orders.

Management and Labour

Employment statistics show that there was a fall in the labour force employed in the production of locomotives and railway track equipment from 71,200 in July, 1959, to 68,400 in July, 1960. This suggests that although total deliveries of locomotives in 1960 appears to have been well maintained, the decline in export demand had already resulted in a contraction in the volume of work in hand.

The number employed in aircraft manufacture and repair showed very little change, amounting to 280,900 in July, 1959, and 280,200 in July, 1960. This is undoubtedly one of the factors leading to greater optimism in the industry since for some time estimates have been in circulation that the industry is likely to contract until employment falls to about 150,000. There has of course been a fair amount of diversification, which is probably not allowed for in the employment statistics.

Employment in the manufacture of motor vehicles rose sharply from 388,000 in July, 1959, to 442,000 in July, 1960, though there was considerable short time working in the latter part of the year. In the week ending 29 October, 1960, a total of 63,500 employees in the motor industry were on short time. If the present recession continues for any length of time the industry will be faced with the difficult problem of deciding whether to continue short time working or to reduce the labour force. In many industries short time working is not long in bringing its own corrective, since employees tend to move elsewhere in order to maintain their earnings. In the motor industry, however, earnings (including overtime) were exceptionally high in the earlier part of last year and many employees may prefer to continue for a considerable period on short time in the hope that opportunities may return for high earnings.

In shipbuilding and marine engineering there was a fall in employment between July, 1959, and July, 1960, in the former from 261,400 to 250,000 and in the latter from 74,600 to 71,400. Further cuts in employment are expected in the current year.

Plant and Materials Supplies

Two of the industries covered in this article, namely, motor vehicle manufacturing and shipbuilding, are of major importance as consumers of steel. In the first eight months of 1960 deliveries of steel in all forms to manufacturers and repairers of motor vehicles, cycles and aircraft, averaged 32,100 tons per week compared with 30,400 tons in the corresponding period of 1959. While the bulk of these supplies consisted of sheet, strip and plate under $\frac{3}{8}$ in thick the industry is also an important user of alloy steels, taking about one-seventh of total UK deliveries.

The high level of activity in the motor industry in the early part of 1960 was reflected in a marked rise in imports of non-alloy steel plates and sheets (uncoated) from a monthly average of 22,000 tons in 1959 to an average of 59,000 tons in the first ten months of 1960. By October of last year, however, the monthly figures had returned to 22,000 tons.

Steel consumption by the shipbuilding industry, which is mainly in the form of plates over $\frac{3}{8}$ in thick, has been declining since 1957. In the first eight months of 1960 it averaged 11,800 tons per week compared with 12,400 tons in the corresponding period of 1959 and 18,800 tons in 1957.

The main raw materials for the aircraft industry is of course aluminium and aluminium alloys, though purchases of steel are of the same order of value as those of aluminium. Total UK despatches of fabricated aluminium and aluminium alloys in the first seven months of 1960 averaged 34,600 tons per month compared with 30,100 tons in 1959.

Production

Towards the end of last year it became possible to see more clearly the lines on which future development of the aircraft industry may proceed. The British Aircraft Corporation was considering the completion of the range of jet air liners under development, which already included the long range Super VC 10, the VC 10 and the projected medium range VC 11, by a short range jet which might ultimately replace the Viscount. A. V. Roe and de Havilland, both members of the Hawker Siddeley group were also reported to be working in this field.

In the longer term, interest centres on new developments such as vertical take-off aircraft and supersonic airliners. The Government has already had discussions with the industry on these projects and assistance has been afforded in the case of the Rotodyne. BOAC have urged that a start should be made on the design of a supersonic airliner but with development costs

estimated at a minimum of £80 million and with the International Air Transport Association expressing the opinion that supersonic airliners will not be required until after 1970 and that the market will not exceed about 40 aircraft a year for three years, some further delays may be expected before the decision is taken to proceed.

Expansion and Investment

The new shape of the aircraft industry was already determined in broad outline by the end of 1959 and the past year has seen mainly behind-the-scenes reorganisation of the two major groups in the industry, the Hawker Siddeley Group and the British Aircraft Corporation. At the time the decision was taken to establish the second group, Westland Aircraft, which had already acquired the helicopter side of Saunders Roe, took over the Helicopter Division of Bristol to form the largest company in Europe specialising in helicopters. Apart from Rolls-Royce this left six uncommitted companies, Short Brothers and Harland, Handley Page, Fairey Aviation, Auster, Scottish Aviation and Alvis. Auster has subsequently been acquired by the Pressed Steel Company and proposes to concentrate on small executive-type aircraft.

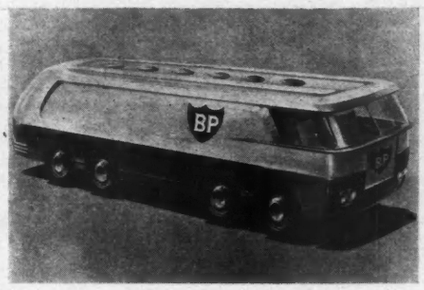
Shortly after the amalgamations had taken place the Government announced that it would provide additional financial help for the production and sale of civil aircraft but would also participate in the proceeds from sales. It was not until July, however, that the Minister of Aviation decided which projects should be supported. These were four in number, the De Havilland DH 121 Trident, the Armstrong Whitworth Argosy and the Vickers VC 10 and Super VC10. BEA had already ordered 24 DH121's with an option for 12 more while BOAC had ordered 35 VC10's valued at £60 million and 10 Super VC10's. Government support was also announced for the Rotodyne vertical take-off airliner designed by Fairey but due for production by Westland, and small orders were also placed for the Avro 748 and Handley Page Herald transports to help in proving them. A. V. Roe and Company announced later in the year that they proposed to double the output of the Avro 748 though the cost of this would be borne entirely by the company.

The motor industry has already announced plans for the expansion of capacity by about 750,000 vehicles per annum equivalent to rather more than 50 per cent of the current rate of production. This will bring total potential output to between 2 and 2¼ million private cars per annum.

Regarding organisation of the industry the outstanding events of the past year were the decision of the US Ford Company to acquire the outstanding balance of shares in the British subsidiary and the offer by Leylands to purchase Standard-Triumph.

In the field of research total spending by the British Shipbuilding Research Association rose by £53,000 to £330,000 in the year ending 31 March, 1959/60 and is expected to rise to £435,000 this year. This is a welcome development, but the industry would appear to have lost an outstanding opportunity substantially to increase research expenditure during the years of relative prosperity which now seem to be coming to an end. Though many of the leading companies have completed modernisation schemes, the industry would appear to be entering a period of recession less well equipped to meet the anticipated intense competition than might have been the case.

The chairman of the Swan Hunter Group was probably correct when he refuted suggestions that the British shipbuilding industry should be reduced in size in view of the world surplus of shipbuilding capacity, but if the industry is to retain the level of output of the last few years every effort will have to be made to reduce costs and speed up the time taken to build a ship. In order to achieve this some grouping of companies may be necessary as suggested by Mr.



Frameless light-alloy Leyland-Thompson tanker.

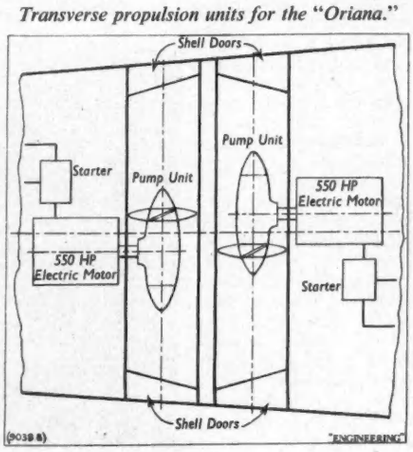
T. W. D. Abell in his presidential address to the Institute of Marine Engineers (Scottish Section). He claimed that more standardisation in shipbuilding and marine engineering would provide the answer to foreign competition and envisaged, for example, a single marine engineering company supplying the main Clydeside yards. At the present time, of the 16 Clydeside yards, nine build machinery and there are three additional companies building machinery for them.

Long Term Research

Long-term research projects likely to affect the future of all elements of the transport industry include those concerning further development of existing systems and vehicles and those probing the possibilities of potential rival systems. In road transport there is continual development of established petrol and diesel engines and a big jump ahead in specific power is claimed for a new petrol engine designed by an American, Mr. Lloyd Taylor, and built by the Tyce Engineering Company. The engine is constructed entirely of brazed stainless steel plate and tube and early examples are said to be producing 1 bhp per lb weight. Diesel engine research is aimed at more accurate matching of turbochargers to engines to provide torque curves acceptable for automotive application; an objective being the eventual provision of a wide range of powers from one one or two basic frame sizes and common components. Complementary work on transmissions seeks a system that will provide an infinitely variable ratio, between design limits, of high efficiency that will permit the engine to work in its most efficient range under conditions of constantly varying load and speed. The hydrostatic transmissions now under active development could provide a solution, while another approach that might yet find practical solution is an infinitely variable mechanical transmission based on the Beier gear.

Possible future rival road vehicle power units, all of which are attractive because of torque characteristics favourable for automotive application and thus hold out the possibility of eliminating the troublesome change-speed gear or torque converter, are the gas turbine, the free-piston gasifier with turbine and the fuel cell with electric traction motor. Early car, lorry and bus

Transverse propulsion units for the "Oriana."



applications of the gas-turbine worked well but were highly inefficient as far as fuel consumpton was concerned. Recent work has solved the problems of design of a regeneration cycle that provides fuel economy, it is claimed, comparable with that of the diesel engine.

The free-piston gasifier looks less promising; although it has been developed into an extremely efficient unit in the 1,000 hp class, its very high compression requires massive construction unsuited to road vehicle application. Nonetheless, work on gasifiers of suitable size and power is proceeding in Britain and the USA. Work is also proceeding on the electrochemical fuel cell, the appeal of which rests on simplicity of construction, ease of control and the favourable operating characteristics of the electric motor already referred to.

Research into a whole series of air-cushion riders now being actively pursued in a number of countries will, if successfully concluded, be quite likely to affect certain classes of road, rail and marine transport. The Hawker Siddeley Hovertruck project has been mentioned earlier and looking further ahead, Mr. Christopher Cockerell, the originator of current British work, has predicted that a 1,000 ton Hovercraft ferry could be built for about £4 million and could do the same work as five or more 3,500 ton conventional Channel ferries. Operating costs of such a vehicle at speeds of 70-100 knots would be similar to those of a normal ferry at 16-20 knots. This aspect of Hovercraft development in Britain is in the hands of William Denny and Brothers.

Since the controlled extraction of power from atomic reaction first became practicable, such a system has looked attractive to transport men for the low weight and bulk of its fuel requirements and consequent unprecedented range and freedom from refuelling limitations. Apart from initial and operating costs, the weight and bulk of the necessary shielding from harmful radiation more than offset potential gains and have so far precluded development of automotive atomic engines other than for use in naval submarines. That further progress will be made in reducing level and intensity of radiation and with shielding materials is credible, opening the way for development of practicable power units, perhaps first for marine and thereafter for air and railway use.

One of the more certain developments in the foreseeable future is the supersonic airliner, but what is less certain is just how big a jump forward in speed the initial supersonic design offered to the airlines will take. Sir George Edwards said recently that the British industry already knew how to make a Mach 2 machine but that nobody yet knew how to make a Mach 3 transport. British inclination is towards the Mach 2 to 2·3 project as a first step and there is little doubt that experience with military aircraft up to this level has provided all the knowledge necessary, of both turbojet engines and airframe structures, for the development and proving of a Mach 2 transport by the end of the present decade.

Forecast

As the world's need of efficient transport increases, so do the opportunities open to the transport manufacturing industries. They can find new applications for established designs and inventiveness for new ones.

In the immediate future the NSU-Wankel engine looks promising and could conceivably replace the familiar internal combustion engine as we know it today, perhaps for small sizes. An extension of the use of automatic transmissions down to the smaller cars seems inevitable and disc brakes will be seen in increasing numbers as production rises and costs are reduced.

The first commercial ground-effect machines will not be long before they are seen in use. Elders and Fyffes have already seen the value of the Britten-Norman Cushioncraft for their banana plantations and are cooperating in the vehicle's development. Some of the various developments of the basic design of the Hovercraft are due to fly this year.

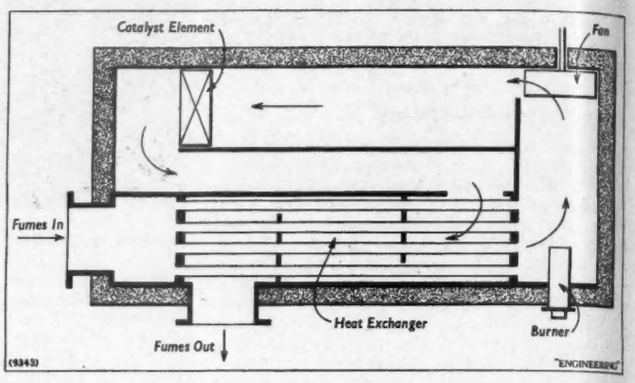
Catalytic Combustion for Clean Fumes

The Burgh Heath depot of Kinloch (Provision Merchants) Limited, is situated in a residential area on the Surrey Downs and so, when it was decided to install a new bacon smoking unit there, care had to be taken not to mar the amenities of the area. The local authorities were insistent that there should be no discharge stacks, and that the fumes from the bacon smoking process should not contain any colour or objectionable odour.

Various methods of treating the fumes were considered by Kinloch's who finally decided that the Holmes-Catalytic process would meet all their requirements since it has been proved that an effluent, free from colour and odour, could be produced by this method.

The heart of the process is an all metal catalyst unit containing metals of the platinum group. The catalyst promotes combustion at a temperature well below that required for direct incineration, and produces the usual products of combustion. The smoke is pre-heated to the catalytic ignition temperature by direct heating with an oil burner. To conserve heat, the treated gases are passed through a heat exchanger to help in the pre-heating of the incoming smoke. A circulating fan is installed to draw smoke from the oven and to pass it through the process. The plant is fully instrumented to reduce supervision to a minimum.

A proportional temperature indicator is used to regulate the quantity of oil supplied to the burner, the operation of which is controlled by flame failure equipment.



A schematic diagram of the plant which renders fumes from the bacon smoking process colourless and odourless.

Overriding safety controls operate in the event of excessive temperature at the catalyst surface, excessive oil pressure at the burner head, or smoke flow failure in the plant.

Maintenance of the equipment is kept to a minimum and is confined to routine lubrication of the bearings of the circulating fan, of the fan which supplies air to the oil burner, and of the associated electric motor drives.

The plant has now been in operation for some time and it has been found that, in addition to doing its main job of treating the fumes, a number of other advantages have resulted from its installation. The extraction rate of smoke from the oven is under control and is independent of atmospheric conditions, the density of smoke inside the stove is more even than is usual with natural draught units, and the temperature at which the bacon is processed is more uniform.

The makers of the plant were the chemical engineering division of W. C. Holmes and Company Limited, of Huddersfield.

Granulation of Molten Iron

It is only five years since the first pig iron granulation plant was erected at the Wellingborough works of Stewarts and Lloyds Limited, yet this simple technique of globulating iron by pouring the molten metal directly into large reservoirs of cold water has proved so successful that, during this time, no less than five other companies have placed firm orders for similar plants with the licensing agents, John Miles and Partners. Three of these are already in full production.

Undoubtedly the great attraction of the process lies in its ease of operation, low maintenance costs, and in the transportability of the final product. In this last respect, the process offers considerable advantages over conventional pig-casting machines which produce short rectangular " pigs " or slabs of iron.

Although the basic principle of the new process is very simple it has, nevertheless, proved itself sufficiently adaptable to suit the individual requirements of each of the companies, both here and abroad, who have adopted it. At the Wellingborough works, for example, there is a blast furnace plant but there are no steelmaking furnaces so that the iron must be transported to Corby, 18 miles away. The original experiments indicated, and subsequent operation of a twin-chanelled pilot plant with a throughput of two tons of metal a minute has proved, that over a distance such as this, which is really too great for the transfer of metal in the molten state, granulated iron can be transported with a high degree of efficiency. The molten metal, tipped from the ladle by an overhead crane, flows along the runner and divides into two separate streams before it drops into jets of water which pour forth at the rate of 60 gallons a minute. With the water at a pressure of 6·5 lb per sq. in and at a temperature of about 20° C, it is possible to produce globules as large as pigeon's eggs although, as a rule, at least 25 per cent of the product is much smaller.

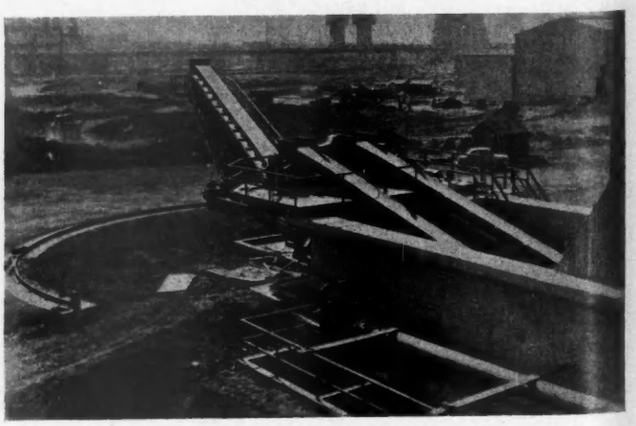
The granulation plant at the Port Talbot works of the Steel Company of Wales, which started production some two years ago, is, in comparison, somewhat larger. It has four banks of sprays and although the amount of water used is the same as that of Wellingborough, it has a much higher throughput—nominally about four tons a minute. The product is transferred to stock by two primary conveyors and a secondary swivelling conveyor.

Another variation of the process is that used at the Joeuf works of the SA de Wendel et Cie installation, in France; here the hot metal flows directly from the blast furnace and, because it is impossible to control the flow of iron from the tap hole, an escape runner is provided. The product is collected in water-filled concrete tanks and the metal flow is diverted as soon as the temperature of the water reaches 90° C. As is the common practice in many steelworks, the solid iron is either charged to the open hearth furnace or, for convenience, recharged to the blast furnace and remelted there. It is in this way that the productivity of the blast furnace plant may be dovetailed with that of the rest of the steelworks.

The latest plant to come into operation is the one at the works of Esperance Longdoz, near Leige, which started producing granules just a few weeks ago. Throughput is about four tons a minute, and since water is plentiful its flow rate is increased, as the temperature rises, from about 600 gallons a minute to just twice that value.

Normally, the treated product is removed on two primary conveyors, a secondary conveyor, and a transfer car before being discharged into blast furnace stock bins. Should these stock bins be full or should the transfer car be in use, the product can be taken off the secondary conveyor half way along its length and delivered into road or rail wagons. The railway wagons can then be used for transferring the granulated iron to a stockpile, but the road vehicles usually bring the material back to the granulating plant where it is unloaded by electromagnets and delivered into hoppers from whence it may be discharged once again on to one of the primary conveyors.

Experience at all of these works has confirmed the view that the granulation process has many advantages over the conventional pig casting technique. Apart from the fact that the product is much easier and more economic to handle the cost of operation is only about a third of that of a pig-casting machine. The ground area required, cost of installation and maintenance, wear and tear of transporting and blast furnace charging equipment, is less; and the granules, which require much less fuel for remelting, may be stocked without difficulty. No doubt the future will see a continued expansion of this process within the steel industry.

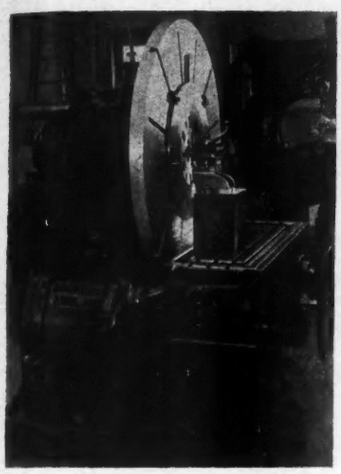


The granulation plant at the Port Talbot works of the Steel Company of Wales.

Milling Machine Turned Lathe

An Archdale milling machine is being used as a lathe in the Quebec works of the Foxborough Company Limited, the Canadian instrument manufacturers. They report that because production requirements seldom justify the purchase of special equipment for each new machining problem, existing machines must often be adapted for multi-purpose operation.

Foxborough's problem arose in this case as a result of the demand for their larger flow meters. These meters use the pressure drop across an orifice plate to measure flow, and the accuracy of the measurement is controlled by accuracy of the orifice plate hole.



Position of tool and workpiece are reversed in this adaption.

In the first instance, it appeared that a special large lathe would be needed to cope with plates up to 24 in diameter which have to be machined to 0·001 in on the bore. Identification tabs extending three to four inches beyond the outer diameter of the plates added to the problem.

However, tooling costs would not justify the purchase of such a machine, and so the company decided to convert their 20 in horizontal milling machine.

By retracting the overarm, Foxborough found the machine would take a 40 in diameter swing. A special aluminium faceplate was designed and fitted, and a swivel toolpost was attached to the table so that it could be operated in the same way as the cross slide on a lathe. The results of these alterations can be seen in the illustration.

The milling machine/lathe is reported to be giving good service in both its roles. It was made originally by James Archdale, a member of the Staveley Group of Companies.

More Expansion in Steel

Two Sheffield engineering companies acting together as a consortium have secured a contract worth £2¼ million to build rolling mills required for the new Tinsley Park works of the English Steel Corporation Limited. They are Davy and United Engineering Company Limited and the Brightside Foundry and Engineering Company Limited, members respectively of the Davy-Ashmore Group and the Brightside Group. The whole Tinsley Park project will cost something like £26 million.

The contract covers plant designed primarily for the quantity production of high quality alloy and special carbon steel billets. It consists of a 42 in by 102 in blooming and slabbing mill, two 32 in by 84 in reversing billet mills and an extensive range of billet finishing equipment. Provision is being made in the layout of the new plant for the subsequent addition of a third billet mill stand at a later date.

The plant, which is expected to be in full operation early in 1963, will treble billet output at ESC, lifting it from 130,000 to 380,000 tons a year. It will also enable more economical production to be effected.

In addition to rolling special steel ingots weighing between 2½ and 5 tons for conversion into billets, the blooming and slabbing mill will also be equipped to roll slab ingots of stainless steel weighing 10½ tons to feed the neighbouring hot strip plant of Shepcote Lane Rolling Mills Limited, in which ESC have an interest through Firth-Vickers Stainless Steels Limited.

Shipyard Modernisation

The latest stage in the modernisation of the Pallion shipyard of Short Brothers Limited of Sunderland, has been the construction of a plate preparation shop which combines simplicity of operation with low capital cost. Members of this company were responsible for the design and, apart from the foundation work, for the building of the new shop. Much of the material used to equip it was manufactured or was readily to hand in the shipyard itself.

The effect of the development is to enable a foreman and 20 operatives, including two crane drivers, to prepare steel plates, ranging from a quarter to one and a half inches in thickness and weighing up to 3¼ tons, at a steady rate of more than 10,000 tons per annum, working a single shift and a 42-hour week. At present 80 to 85 per cent of all the shipyard plates go through the shop: eventually a total of more than 90 per cent will be achieved.

Pallion shipyard is best suited to the building of dry cargo ships of the shelter deck ore or bulk carrier type up to 22,000 tons deadweight, although the construction of smaller specialised ships, such as bulk cement carriers, is under consideration.

The preparation shop and its method of handling the plates were evolved to meet these particular requirements, and to provide for a certain amount of riveting if wanted by owning companies.

Adjoining the shop is a stockyard measuring 240 ft by 90 ft, marked off for various sizes of plates, and served by an overhead Goliath electro-magnetic crane, which unloads railway wagons and stores the steel, and, when the need arises, starts each plate on its journey of preparation, passing it through levelling rolls before it enters the shop proper through one of two feeding slots.

The lay-out and equipment of the shop is very simple. Elaborate production control systems and electronic apparatus have given place to a series of inverted castors—more than 800 of them set on an incline of half an inch to the foot in much the same style as launching ways.

Gravity thus carries the plate through the various stages of preparation. The plate rolls into the shop and on to one of two transporters, each of which serves three processing bays. By pneumatic control, the transporter can be elevated slightly to make the plate travel along the selected bay. Rubber and nylon are used to reduce the shock impact of heavy plates where necessary. At each stage in the process—the marking, the cutting, and (if riveting is wanted) the drilling and the countersinking—the movement of the plate is arrested by a simple foot-operated mechanical device, and stoppers and castors are protected by raising the bed on pneumatic jacks. When the operation is completed the plate is removed by crane to storage racks at the head of the building berths.

Foundations have been laid recently in this shop to carry an 800 ton press, which is to be installed early this year. This press, which will have its own slot from the stockyard, and which will be served by two powered jib cranes, will trough bulkhead plates up to 30 ft in length, swedge light superstructure plates, flange girder plates, and turn mast plates in one complete circle—all in the interests of reducing plating costs still further.

As explained, this venture marks another stage in the shipyard's overall modernisation scheme. The company recently brought into service a well equipped fitting out quay, and the building berths are now being reconstructed prior to the introduction of new cranage.

Charting Progress through a Works

The accompanying illustration shows a wall chart system which is in use at the Halesowen, Worcestershire, works of Walter Somers Limited. Some 300 orders for crankshafts and large forgings are progressed through six main stages and ten subsidiary stages on four charts. This particular system has several interesting features, foremost of which is the fact that overdue items can be found quickly—in fact, they are immediately visible. In addition to this, the load on any one department can easily be ascertained from the charts.

Down the left hand side of each of the four charts, there is a card index system. Details of each order received by the company are entered on an index card: the information including planned dates for each stage of production and, subsequently, the actual dates. The lower edge of each index card lines up with a flow line on the chart—a horizontal elasticated cord.

A date scale, covering a period of six months, runs along the top and bottom edges of the charts and the flow line is extended across the panel terminating at a point which indicates the delivery date required for the order. A vertical cursor line moves to give the current date.

Different coloured pegs are inserted at various distances along the flow line to denote the planned dates for the various stages of production; for example, red represents forging and white represents machining. On the completion of each stage, the peg is removed. Therefore, any pegs remaining in place to the left of the cursor are overdue and need to be chased. In fact, another cursor, in yellow, is also used. It travels a fortnight ahead of the current date cursor to give adequate warning of items which might have to be chased.

When information about the load in any particular department is required, a count of

Keeping an eye on progress and department loading.

the pegs of the appropriate colour provides the answer.

The charts used in this system are known as Movigraph Rotadates. The basis of the Movigraph system is a perforated panel and in the Rotadate variation there are three or more such panels sliding in horizontal channelled sections. When the period covered by the first panel is over, that panel can be removed and the remaining panels slid to the left to leave room for the insertion of a fresh panel in the vacant space on the right.

Thus, any situation can be plotted for an indefinite period of time both smoothly and efficiently.

Generator for Exhaust Pulse Studies

With increasing use of supercharged two-stroke engines, more research is needed into the transient exhaust flow conditions. An exhaust pulse simulator has been developed for this purpose.

By W. A. Woods, Ph.D.

Department of Mechanical Engineering, University of Liverpool

DURING the last decade, more and more attention has been given to supercharging the large marine two-stroke cycle engines; this has followed similar lines to that of the four stroke cycle by using the turbo-supercharger principle. In the case of the two-stroke cycle engine, the problems of transient flow in the exhaust pipework are much more important than those in the four-stroke engine.

In order to study the transient flow phenomena in the engine and exhaust pipes, a special exhaust pulse generator machine was constructed in the mechanical engineering laboratories of the University of Liverpool; the object being to simulate the transient gas flows which occur in actual engines. The results of some of the experiments carried out on the machine have already been reported.[1, 2]

This article gives an outline of the reasoning which led to the design of the machine.

ONE-DIMENSIONAL FLOW

The machine was intended to simulate an opposed piston uniflow engine and, at the same time, to represent a simplified "one-dimensional flow" type of apparatus. The flow into the exhaust system was of particular interest, therefore the part of the engine cycle which had to be simulated was that between the exhaust port opening (EPO) and exhaust port closure (EPC). Thus the machine would be able to reproduce the exhaust blowdown from the cylinder and the scavenging and charging periods of the actual cycle. At this stage it was decided that the exhaust and supercharge air ports should be located at opposite ends of the cylinder, rather than have a series of ports situated around the circumference of the cylinder. By adopting this technique the right angle bend in the flow was obviated and a near approach to a one-dimensional system was realised.

The location of the ports at the end of the cylinder meant that the pistons would have to be excluded; thus, a second simplification was made. However, it should be appreciated that the change in volume which takes place between EPO and bottom dead centre is not normally of great importance.[3]

In order to prepare the cylinder for the exhaust blowdown some provision was required for "charging" the cylinder to a pressure of several atmospheres. The charging process was achieved by supplying the cylinder with high pressure compressed air over that period between the closure of the exhaust and supercharge air ports and the opening of the exhaust port (other machines working on a similar principle have been used, notably by Jenny[4] and Benson[5]). The use of "cold" compressed air simplified the situation from that obtaining in an actual engine. With cold "exhaust gas" there would be no severe heat transfer effects, corrosion and wear would be reduced and pressure indicating techniques could be simplified.

However, it was appreciated that heat transfer effects and wave reflections arising from large temperature discontinuities may well be of major importance in actual engines. It was considered that if a theory could be produced to describe the flow conditions on this simplified model, the theory could be modified at a later stage to deal with the full complication of the actual engine case.

As the ports were located in the ends of the cylinder, it was convenient to operate them by means of circular disc type shutters. The shutters were provided with ports to correspond to those in the cylinder. A half cross-section through the exhaust pulse generator machine is shown in Fig. 2. In order to provide cylinders of varying size and to maintain geometrical similarity for the exhaust port opening/"crank angle" relationships, the ports were made as part of a sector of a circle; the cylinder and port combination was situated at a radius proportional to the diameter of the cylinder. With this arrangement, a linear relationship between the port area and the crank angle was obtained which simplified the theoretical treatment of the investigation.

The exhaust ports were located at one end of the cylinders and at the other end supercharge air ports and high pressure air ports were provided. Each shutter rotated between an annular plate, to which the cylinders were attached, and an end plate to which the exhaust pipes and inlet pipes were respectively fitted. The clearance between the moving surfaces was made small (order of 0·005 in) in order to minimise air leakage.

In order to reduce the rubbing velocity on the

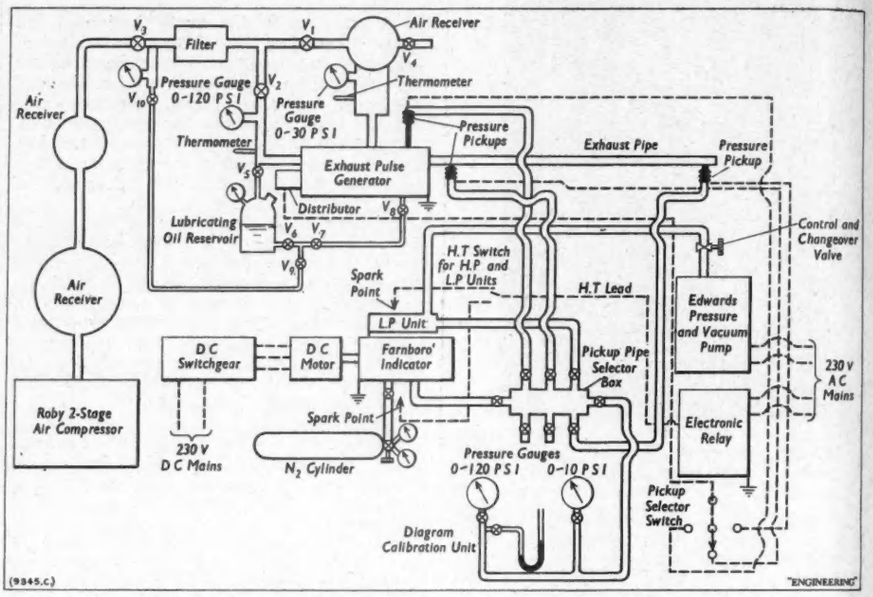


Fig. 1 Schematic block diagram of exhaust pulse simulator system

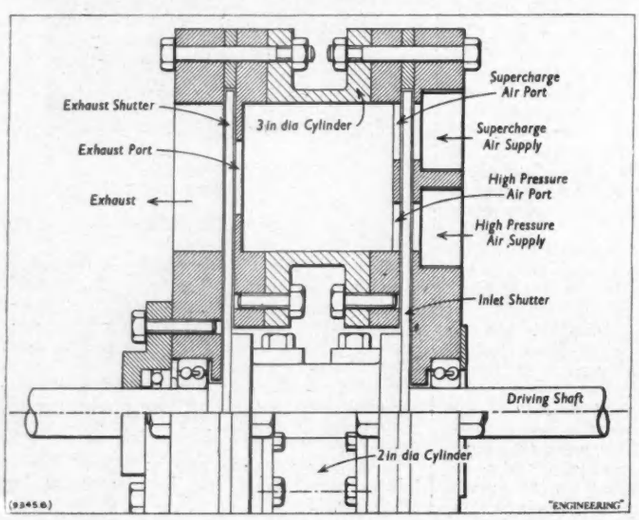


Fig. 2 (left) Half cross-section of exhaust pulse generator.

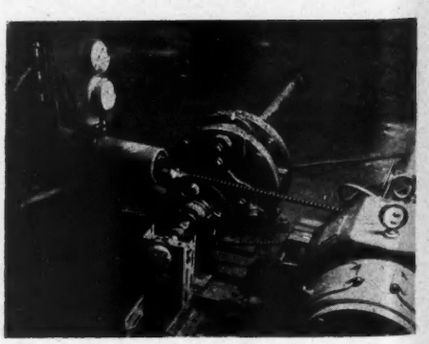


Fig. 3 (right) The apparatus enables the exhaust conditions of a supercharged two-stroke engine to be studied closely.

disc surfaces, three sets of shutter ports were incorporated 120° apart. With this arrangement three cycles were obtained for each revolution, thus the equivalent engine speed was three times the shutter speed. The shutter shaft was driven by a variable speed, direct current electric motor through a 3 to 1 chain reduction drive. A Farnboro' electric indicator was driven directly from the electric motor so that one revolution of the Farnboro' indicator drum corresponded to one simulated engine cycle.

The cycle of events for the exhaust pulse generator was as follows: the high pressure air port was first opened and compressed air admitted to the cylinder, which was charged to the desired pressure at the point where the high pressure port closes. The exhaust port was then opened, followed by the exhaust blowdown and then the supercharge air port was opened. Both ports remained open for a fixed period before the exhaust port closed, slightly in advance of the supercharge air port. This corresponded to the scavenging and charging periods in actual engines. The high pressure port again opened and the sequence of events was repeated.

FUTURE DESIGNS

From the experience gained during the development and operation of the apparatus described in this article, a number of possible improvements presented themselves and some of the weaker design points became apparent; hence, it is appropriate to set down recommendations which, it is hoped, will be useful to engineers who are concerned with the construction of similar machines.

The chain drive was the cause of a certain amount of vibration and slight relative movement between the exhaust pulse generator shaft and Farnboro' indicator drum. Although the latter was not very large, vibration was most un desirable. Hence, a direct or a gear drive would be a better suggestion.

The disc type shutters necessitated larger working clearances than had been anticipated in the design; use of thicker shutters would improve the mechanical operation. The machine described was designed with three cylinders of 2in, 2·55 in and 3 in bore, and all the experiments carried out on the machine to date have been on the 2 in diameter size, hence, a simpler design could be obtained if only one cylinder was used.

Acknowledgments.—The author wishes to thank Emeritus Professor W. J. Kearton and Dr. R. S. Benson for their help and advice concerning this work.

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Continuous-Wave Optical Maser Looks Practical

A significant advance in the comparatively new field of "optical radio engineering" has been announced by IBM United Kingdom Limited, Wigmore Street, London, W1. By making use of the elements uranium and samarium, IBM have been able to develop an optical maser capable of emitting a continuous, coherent wave of light.

The potential value of these optical electromagnetic waves does not appear to lie in their visibility, but in their highly directional properties. For instance, in the case of the IBM system, the output of the optical "transmitter" occurs in a beam with an angle of less than half a degree. According to IBM engineers, this will be of considerable value in such activities as data processing, control of chemical reactions and short-distance radar.

Experimental results which proved that coherent electromagnetic waves could be produced at optical frequencies were announced a few months ago (ENGNG., vol. 189, 11 Nov. '60, pp. 654 and 655) by research engineers of the Bell Telephone Laboratories in the USA. The statement now made by IBM indicates that very important advances have since been made, and that the practical application of such devices has been brought much closer.

NEW APPROACH

The IBM system, which was developed in their American laboratories, makes use of an entirely new approach to the generation of coherent light, both in the visible and infra-red regions of the electromagnetic spectrum. Coherent waves are produced by synchronous and cooperative (in phase) oscillations of ions introduced into a crystal. The resulting light waves have a sharply defined frequency and propagate a very narrow cone of radiation.

Two new optical masers (Microwave Amplification by Stimulated Emission of Radiation), based on the new IBM approach, have so far shown promise. Both emit intense beams of coherent light, one at a wavelength 2·5 microns in the infrared region and the other at 0·708 micron, in the red light region.

These masers, which operate on about 0·02 per cent of the power required by a ruby optical maser, are based on ions of rare earth and transuranic elements that have not previously been used. For this reason, they do not merely represent a development of the original ruby maser, but are in fact entirely new. The major advantage of these masers over the ruby type is that they are capable of generating *continuous* waveforms. The ruby maser has, so far, only been able to emit widely separated pulses of light of about one millisecond duration.

It is because ruby optical masers require pumping powers of the order of kilomegawatts (thus giving rise to serious cooling problems) that their operation is restricted to short pulses.

In the IBM maser, using uranium or samarium, stimulated emission occurs when the metastable state contains an excess of excited ions over the terminal state, by about a factor of ten. The excess required for stimulated emission using a ruby rod is substantially greater.

One drawback with the IBM technique is that cryogenic temperatures are required to keep the crystal rod down to about 40° K; this prevents the terminal state from depopulating. In the case of the pulse operated ruby maser, cryogenic temperatures are not required—in fact they can be operated at room temperature.

According to an IBM report, continuous generation of coherent light offers some exciting possibilities in space exploration. A tiny device transmitting a narrow beam of coherent light could be used for "optical lane" navigation. Airport traffic control and short-distance radar might also be operated on the optical master principle, making use of the sharply defined, narrow beam-angle for highly accurate positional control and definition. However, the problem here would be absorption of the light by dust and mist.

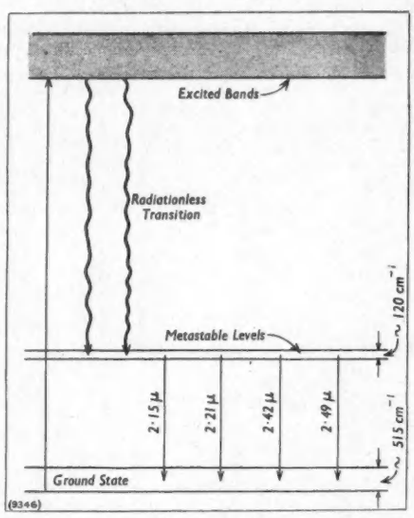
Trivalent uranium ions (so called because three electrons are removed from the uranium atom's outer shell) are the key to the new infrared device; divalent samarium ions (two electrons missing) are reponsible for the visible red light maser. Both types use a "host lattice" of calcium fluoride, in which one-tenth of one per cent of the calcium ions are replaced by uranium or samarium ions. Calcium fluoride is quite commonly used in optical work.

CONTINUOUS OUTPUT

The key to the success of the IBM maser in producing *continuous* coherent light waveforms is said to be the use of the trivalent and divalent uranium and samarium ions. These apparently overcome the limitations of ruby in this respect. From the point of view of further engineering work, this means that work can now be concentrated on the optical system; whereas, in the case of the ruby maser, a fair amount of materials research has yet to be done.

Theoretically, it is anticipated that further work on the optical system will reduce the present half-degree beam angle by several orders of magnitude. If it can be produced, such a beam would be so sharp that over a distance of 100,000 miles it might be possible to focus on a surface of less than one mile in diameter. Compared with this, an ordinary microwave transmitter would scatter its beam over an area with about 10,000 miles diameter.

Though research and development in this new field of engineering is in its early stages, it is



Uranium ions are "pumped" to excited bands, then non-radiative transition takes place to the matastable states.

nevertheless possible to see a number of general applications that may arise from the basic properties of the device. The first significant point that arises is that a new frequency spectrum has been opened up for radio communication.

The advantages of radio communication at these very high frequencies are difficult to envisage at present, but it is not so difficult to foresee possible applications in connection with microwave links. In this respect, the optical maser would be able to offer much higher power densities, due to its highly directional properties. These directional properties would also be useful for communication between artificial satellites, and from satellites to earth, because very low powers would then be required on board the orbiting vehicle.

Optical masers may also be able to provide sources of radiation (particularly infrared) with much greater power at a specific frequency than is at present available. In this case, it may be possible to use them to excite particular molecular vibrations in a selective manner, in order to influence the course of chemical reactions.

Another possible application for optical masers, quoted in a recent report from the Bell Telephone Laboratories, might lie in the improvement of atomic standards of length. In turn, this could extend the distances of optical interferometry methods that are currently being used for high-precision length determination.

Metal Makers Prod Furniture Designers

Engineers have offered very little in furniture design until recently, but now there are active signs that the metal producers are prompting designers to think again.

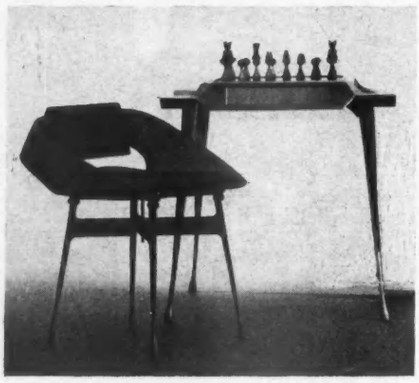
ANY material seeking a new market must stand on its own merit rather than the faults of others.

The United States Steel Corporation of Pittsburgh disclosed last September the results of two years' intensive study and development work, intended to unlock the full potential and personality of steel as a design material in new applications and in refinement of old ones.

The new programme, known as "Study in Steel," is described as a major step in US Steel's campaign to create new frontiers for steel. The Corporation is not in the design business and has no intention of going into manufacture of furniture, but it is offering its design ideas to manufacturers and fabricators with no strings attached.

A firm of industrial designers—Peter Muller-Munk Associates, 725 Liberty Avenue, Pittsburg—were commissioned to conduct the study over a period of two years. While any number of products could have been selected and developed to an ultimate conclusion, furniture was chosen as a major example of what can be done by designers if they utilise fully the characteristics of steel.

To find the metal's "personality" the designers first examined successful applications of steel.



One of Alcoa's "Forecast" designs this chess table employs cast aluminium throughout.

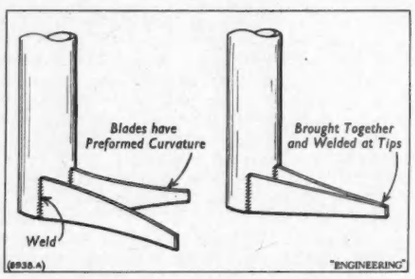
The bicycle wheel is considered an outstanding example: fine radial spokes are stretched between a hub in pure tension and a rim in pure compression. The visually appealing wheel is light, resilient and strong; a great improvement on the traditional wagon-wheel where the spokes can only sustain compression. Prestressing is the clue to the bicycle wheel's success.

The appearance of lightness combined with strength and resilience were chosen as desirable aims in the achievement of which non-ferrous materials would find it difficult to compete. A search began for methods of applying the principle of prestressing, found so successful in the wheel, to other structures in steel.

Lightness can be obtained by supporting loads on slender structural members extravagantly: that is, by transferring the load to the ground by an indirect route. A seat suspended on thin wires from a ceiling appears "light" in spite of the massive walls and beam which ultimately support it. Similarly, a table supported by a single C-leg will appear light in comparison with a traditional three or four legged table. To make full use of steel's extravagant strength a pair of basic furniture legs was developed in which prestressing is used to enhance the illusion of lightness.

In light structures it is difficult to make full use of material strength because the minimum section is not determined by tensile or compressive strength but buckling, resistance to impact, and limits on allowable deformation. A C-leg, with its double cantilever, is a massive structure when constructed of solid beams, and hollowing out the beams into box-girders only reduces the real weight: the appearance remains as clumsy as ever. But a prestressed cantilever can be both light and structurally sound.

The solution adopted by the designers consisted of a prestressed cantilever formed of two thin blades. The blades are welded to the support column with a wide angle of separation, then the blade tips are forced together and joined, as illustrated, To avoid the resulting oval shape, the blades are preformed with a curvature and joined over a short length near the blade tips. The outside fibres of the cantilever are



Two leaves of steel are bent and welded to form a prestressed member that resists buckling.

permanently stressed and the resistance to buckling or twisting is greatly increased.

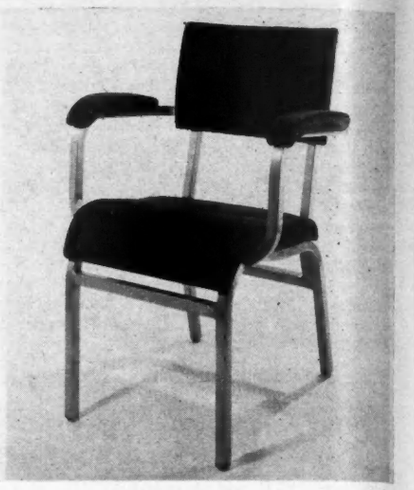
The resilience inherent in C-leg construction is particularly important in modern sitting furniture where the use of foam rubber has created a host of new problems. A foam rubber filled leather armchair looks invitingly soft but has amazing resistance to the impact of someone who sits down abruptly. The C-legs have just the right amount of springiness to remove the "kick," without causing free swinging when fidgeting in the chair.

The boxes for shop display cabinets also utilise steel wherever possible. A light but strong construction was developed using two sheet-steel boxes, one inside the other, the interspace filled with urethane foam under pressure. Prestressing is thus applied to the foam filling rather than the steel case. The pressure filled sandwich construction eliminates the undesirable drumming associated with steel furniture.

In announcing the new design concepts, US Steel said that they intended to show that steel can do a multitude of jobs outside the ordinary. If designers are aware of the inherent characteristics of steel they can produce products that are more practical, more economical to fabricate, and more in keeping with the design trends of tomorrow.

From this side of the Atlantic there is little evidence that the steel makers are as yet thinking of producing designs or interesting designers in the potentials of steel furniture. Perhaps it is because in Britain we have a greater history and culture and the introduction of metal needs gently assimilating. On the other hand, since the Second World War both ferrous and non-ferrous components have been used more and more in furniture design with very pleasing effect.

It is interesting to note that in Scandinavia where trends are generally forward-looking, furniture is still largely made of wood, but this is probably influenced by the fact that timber is the mainstay of the economy.



"Zephyr" chair made by G. N. Burgess with frame from square section aluminium alloy tube.

The aluminium industries in this country do, however, show considerable activity in discovering the furniture design potentials of their material.

World consumption of aluminium has trebled in the last ten years, and figures for 1959 show an increase of 20 per cent over the previous record level in 1956. All this has been achieved in spite of the slowing down of the aircraft industry's requirements.

The British Aluminium Company Limited of Norfolk House, St. James's Square, SW1, will shortly launch a large scale publicity campaign and marketing scheme to introduce aluminium furniture in a big way. It is a scheme in which, as a consequence of full cooperation from the company, the furniture designer and manufacturer is actively encouraged to consider and exploit the potentialities of aluminium, and which also aims directly to create and stimulate buyer appeal.

Reynolds Metals in the US, which is an associate company with British Aluminium, have staff designers of their own and have engaged consultant designers to produce designs for marketing by small companies who do not have their own design teams.

Alcan (UK) Limited, 30 Berkeley Square, London, W1, the other large aluminium producer in the UK, are also obviously alive to the furniture market which can still take a lot more of their raw material. This awareness was evidenced in an exhibition which was organised on their behalf in London late last year. Its theme was "Aluminium in Lighter Living" and sought to show what part aluminium has to play in the homes of the future. Several designs shown were forward looking.

Returning to the American scene again, and still dealing with aluminium, the Aluminium Company of America (Alcoa), through their manager of design, Mr. Samuel L. Fahnestock, made a statement for ENGINEERING on what they are doing. It said: "Aluminium Company of America has been involved for some time in a comprehensive design programme—involving experimental, developmental, and promotional efforts—directed toward many of the areas in which the designer plays a significant role.

"The furniture field is one of these. Alcoa feels that its activities to date have played a major part in winning acceptance for aluminium as a structural and styling material in quality interior furniture. Its current and projected efforts are aimed at broadening this impact, and

extending it to mass furniture manufacture. The company's recent undertakings in this field are characteristic of its future programmes.

"Among experimental activities have been several designs commissioned for Alcoa's 'Forecast' collection: a table by Isamu Noguchi, a chair by Paul McCobb, a room divider by Alexander Girard, and a game table by Gene Tepper, (described later). The company works with designers to develop new forms of the light metal for use in prototype designs; a recent project with Edward Wormley involved an experimental cast aluminium wheel. The company works in its own laboratories to devise new materials or forms for possible use in furniture.

"Alcoa's promotional efforts are directed variously at designers, decorators, manufacturers, and the general public. The communication with designers uses such devices as the company's publication, *Design Forecast*, to tell designers of aluminium's capabilities, and to expose them to the outstanding work of their peers. Alcoa speaks to the decorator in order to explain the virtues of aluminium in the furniture now available. To the manufacturer, the company carries the story of the growth of aluminium in the field, its capabilities in terms of aiding the manufacturers' cost and profit picture, and their promotional programme to create a consumer desire for aluminium in furniture."

To lend detail to Alcoa's statement one of the Forecast designs is described. It is a design for a chess table by designer Gene Tepper and is notable in that it employs cast aluminium throughout. The multiplaned, compartmented top is a single casting, and the legs, as well as the legs and bodies of the companion chairs, are also cast in Alcoa alloy 356. Use of this material represents an optimum for the needs of the design: casting ability, strength and finish.

The table top is one of the most complex castings ever used in furniture design. Three aluminium boards or plates permit the playing of several games besides chess. These plates fit flush in the table top; beneath is a four-section storage chamber for the playing pieces. Different games call for differently marked-out boards and the finish for the Chinese-checkers plate, for instance, was achieved by three mechanical processes—Vacublast, shot-peening and polishing. Subsequent colour anodising resulted in texture variations that define the playing areas.

Companion chairs which were purposely designed have very small, almost vestigial backrests because it was observed that players tend to lean forward in their seat continuously. A unique leg assembly is used for the chairs; with the ball and socket joint in mind as a means of providing desirable give-and-take movement, the designer has used rubber balls in the assembly to provide resilience. The legs are joined by a cradle and are not directly fastened to the metal of the seat. A drawbolt device holds the cradle to the seat. Four rubber balls between the seat and the cradle, isolate the metal elements of the assembly.

In conclusion it can be said that, although in this country we have come to live with metal furniture in our offices and kitchens, there remains a great deal of work for designers to do before we can be persuaded of the desirability or the economy of having it around in our living rooms.

Wood has a natural beauty not inherent in metal, but it also has its limitations as to methods of formability. It is likely that metal will find an increasing number of applications in industries such as that of furniture where elegance and economy are of paramount importance.

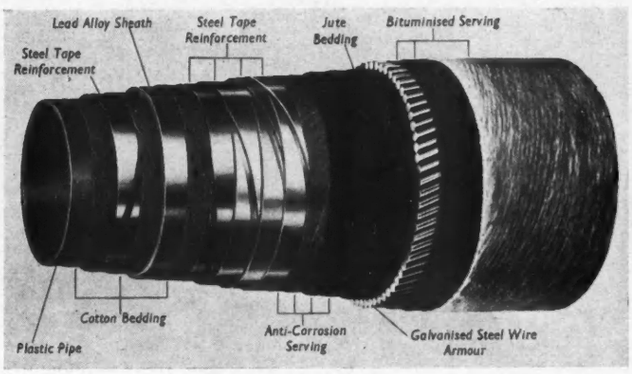
Natural Gas by Flexible Submarine Pipeline

Brief mention was made recently in our Impact columns of the world's longest flexible submarine gas pipeline, which will carry natural gas from the British Columbia mainland to Vancouver Island.

When it is laid, in 1963, the pipeline will bring to consumers on Vancouver Island all the economic advantages of natural gas that at present exist on the mainland. The pipe, which will be made by British Insulated Callender's (Submarine Cables) Limited at Trafford Park, will be installed by the British Insulated Callender's Construction Company Limited, both members of the BICC group.

Coiling will be direct into the hold of the cable laying vessel and not on to drums. The sections will be four miles long and weight per ft is 31½ lb in sea water. With an external diameter of 7·5 in and a bore of 4·8 in the pipe will operate at a gas pressure of 1,500 lb per sq. in. Maximum depth of laying will be about 810 ft.

Two adjacent pipelines will be laid across the Georgia Strait which separates Vancouver Island from the mainland and the pipes will be laid in continuous lengths passing through two intermediate islands which will be crossed with conventional steel pipes. A map of the area will be published in the Engineering Outlook series next week in the article dealing with Service Industries.



With a bore of 4·8 in, the flexible pipeline linking Vancouver Island to the British Columbia mainland will be capable of transmitting 50 million cu. ft of natural gas every 24 hours.

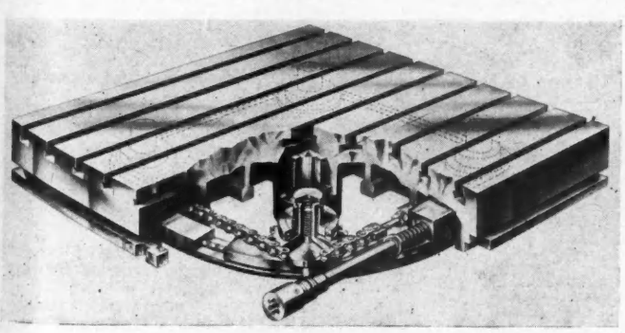
Flexibility is not generally a matter of importance for the installation of land pipes and it is expected that the future of this type of pipeline lies in the field of underwater transmission. It is here that its flexibility and the long continuous lengths facilitate installation.

The Magna Pipeline Company of Vancouver—who are the customer—have specified that the pipeline must be capable of transmitting about 50,000,000 cu. ft every 24 hours which is equivalent to 750,000 hp or 560 MW. BICC were the only competing company who offered a flexible pipeline, and they are believed to be the only company who are at present in a position to manufacture and instal such a system. The illustration shows the constructional details.

Revolving Table for Workpieces has Built-in Jacks

A revolving table using a multi-jack lifting arrangement is now available for Kearns horizontal boring machines. The table, which was designed, and is manufactured, by H. W. Kearns and Company Limited, Broadheath, near Manchester, is made in a variety of sizes from 3 ft to 6 ft square. It is of cellular construction, well ribbed, and the makers say that the metal distribution ensures a high quality casting, combined with maximum strength.

The lifting mechanism includes a screw and nut arrangement which draws a precision roller chain around four sprockets. Each sprocket forms part of a carefully placed jack which transmits the load to a large diameter ball bearing and lifts the revolving table just clear of the main table.



Chain driven sprockets operate four jacks which transmit the load to a large diameter ball bearing and lift the revolving table just clear of the main table.

An even lift is ensured and off-set loads can be easily rotated. The revolving table is located on the main table by a nitrided steel pivot housed in a nitrided cast-iron bush. Because of the balanced lift, binding is avoided and a fine clearance can be used between the pivot and the bush.

During cutting operations, the revolving table is supported on the main table and clamped at all corners. Maximum support is thus ensured to the workpiece with a minimum of table vibration and distortion. Accurate location of the table is given by hardened and ground steel inserts set at each 90° position and these engage with a hardened steel catch fitted in the centre T-slot of the main table.

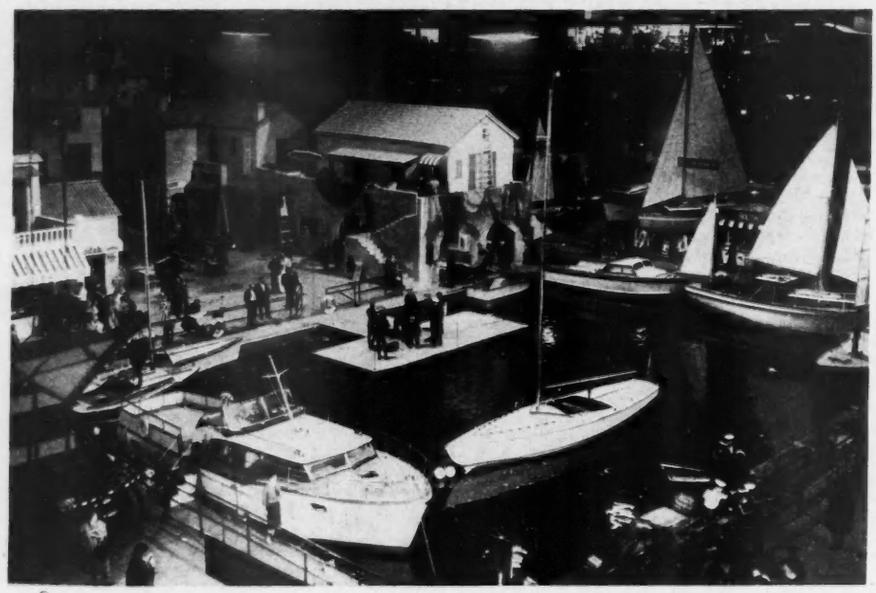
As the lifting mechanism is an integral part of the revolving table, the whole unit may be lifted clear of the central location and repositioned on the main table to suit an individual workpiece.

On the Water

THE busy harbour scene in the illustration may be a sweet foretaste for many this coming summer. It was taken at the *Daily Express* International Boat Show at Earls Court, London, where there were boats and fittings for all pockets. An additional 120 exhibitors this year brought the total up to 480.

On the larger vessels an interesting development is the introduction of fluorescent lighting. This has meant in turn the introduction of alternating current supplies, so following the trend in shipping in general. For those whose boats still have direct current generators, CAV Limited, Acton, London, W3, have produced a transistorised invertor unit to supply the required alternating current. The most important claim for fluorescent lighting is that the consumption is less than with tungsten giving either better lighting for the same power or the same lighting for less power—always an important consideration for those who depend on batteries. Better colour and better distribution are two other claims.

CAV were also showing, in addition to their range of starters and filters, two ac generators designed for battery charging and general lighting. Advantages of the ac generator are



that it will produce a substantial part of its full output over a wide speed range, so that charging will take place with the engine idling, and that it is both lighter and simpler in construction than dynamos and has no commutator problems. Transistor regulators for battery charging, with the great advantage of having no moving parts, were also being exhibited.

As well as 11 petrol and diesel engines covering the range from 2 to 33 hp, Coventry Victor Motor Company Limited, Coventry, were showing a new hydraulic reverse reduction gearbox, suitable for industrial as well as marine applications. This unit is available with ratios of 1 to 1, 2 to 1, and 3 to 1 and can be used with any engine with a torque not exceeding 70 lb-ft at speeds up to 3,000 rpm. The dry weight is 130 lb. The gears are contained in a non-corrosive silicon aluminium housing, resistant to sea water. The clutches are oil operated, cone type, with Mintex linings. There is one for forward and a second for reverse running. Provision is made for remote control by cable if required.

In all, there were some 760 boats on show ranging from a build-it-yourself pram dinghy to a 17 ton auxiliary yawl. Cabin cruisers were on the stands of 83 manufacturers, dinghies on 92, and sailing yachts on 29. Glass fibre construction was popular, made perhaps more so by the possibilities it offers of batch production, in addition to its natural advantages.

An example of a boat using moulded techniques was the "Ranger" built by the Dell Quay Yacht Yard Limited, of Chichester, Sussex. The hull of this yacht is hot moulded in mahogany laminates to give very great strength. The design is by Ray Hunt and affords comfort at high speeds (30 knots and over) even when fitted with full cruising equipment. Power is normally supplied by twin Volvo Penta Aquamatic units rated at 80 hp each. They are installed in a soundproof compartment and give economical cruising at 7 to 15 knots with a top speed fully laden of about 28 knots. The engines are completely independent, even to the fuel supply.

With a length of 25 ft the Ranger has two separate cabins, each of 2/3 berths. There is a separate toilet compartment containing WC, hand basin and shower. The galley includes a built-in gas cooker, stainless steel sink, ice box (or alternatively a refrigerator) and storage cupboards. The central bridge deck is canopied and the after cabin roof can be opened up to form a protected cockpit.

Of more traditional construction is a 30 ft motor sailer/fishing cruiser built by John I. Thornycroft Limited, at their Hampton yard. This is a twin screw cruiser intended mainly for fishing and is ketch rigged with Terylene mainsail, jib, and mizzen giving a total area of 200 sq. ft. In addition a Genoa can be carried. The design is that of Frederick R. Parker Limited, and the construction to Lloyds classification. The hull is of round bilge form with stem, stern frame, deadwoods, keel, planking, and decks of teak. Bent timbers are Canadian rock elm and floors, hog, and deck beams of English oak. Teak is also used for the cabin trunk, wheel house and the cockpit coamings.

The cruiser has a beam of 9 ft 6 in and a draught of approximately 3 ft 3 in. Power is supplied by two diesel engines each developing 16 hp at 1,800 rpm, driving through 2 to 1 reduction gears. Speed under power is 8 knots. The saloon has sleeping accommodation for four persons provided by two settee berths, the backs of which hinge up to form the additional beds. There is a fitted toilet on the port side with basin, cupboards and mirror, and on the starboard side is the galley with cooker, sink, refrigerator and shelves. Aft of the engines and beneath the cockpit is a large fish well reached by floor traps.

ENGINEERING

Published every Friday by Engineering Ltd. at 36 Bedford Street, London, WC2, England.
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